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LOW COST SURFACING BY WPA WITH CINDERS, GRITS AND ASPHALT EMULSION

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Above: Rough Spreading Cinders on 189th St. at Liberty Ave., Oct. 22, 1935

THE Borough of Queens, largest in area and third largest in population of the five boroughs of New York City, has been, and still is, conspicuously underpaved. Since consolidation with the city of New York in 1898 its population has increased from 150,000 to 1,250,000. In the past fifteen years (1921 to 1935 inclusive) the increase has totalled 780,000, or 166 per cent. During this time thousands of moderate priced homes have been built—many of them on unpaved streets without either sewer or gas mains.

Paving Prevented by Charter Restrictions.—Under the provisions of the city charter only a few types of pavement may be laid and paid for by assessment; and as all of these are designed for heavy traffic, and are correspondingly expensive, the requirement has prevented construction of any pavement at all in many sections of low property values.

At the beginning of 1935 approximately 1,500 miles of streets were still in the dirt road class or were improved only with a gravel or cinder surface and a light

Left: First Application of Emulsion and Covering with Grits on 146th St. between 115th and 116th Aves.

Below: Recently Finished Surface on 121st St. between 107th and 109th Aves., Oct. 24, 1935.

Spreading Grits over First Application of Emulsion

surface oiling applied as maintenance. Most of them were in poor condition. Fortunately for the residents of these areas, the natural soil is largely sand or sand and gravel, with good natural drainage; but at that, many streets were practically impassable in bad weather.

The slowness of progress made by the city in permanently improving streets may be judged from the fact that in 1900 there were about 400 miles of improved roadway as against 735 miles in 1934. Progress in the past few years especially has been slow because of the depression, which has affected New York City, in like manner with smaller municipalities and individuals.

Pavement Laid in 1933 on 43rd Ave., Long Island City. Photo, Nov. 25, 1935. This pavement remains in excellent condition, although it is regularly used as a cut-off for heavy traffic from the Queensborough bridge.

Pavement Type and Reasons for Its Selection.—In the setup of work projects for the WPA in Queens Borough, as in most localities, many special handicaps had to be taken into consideration. Laborers were to be drawn from all walks of life, many of them being wholly untrained for any type of road construction work. The same was true in respect to supervision. It was therefore necessary to establish a program which these men could handle without too much difficulty and at the same time produce results.

After careful consideration an extensive program of residential street improvement, sponsored by Borough President, George U. Harvey, was set up, the materials required being cinders and grits, with a penetration treatment of asphalt emulsion. This type was approved by the Works Progress Administration, and it was estimated that about 600 miles of streets could be so improved. This did not mean fine pavements; but it did mean a reasonably smooth, all-weather surface, strong enough to stand up under residential traffic, easily cut through and replaced where underground mains and service connections are to be laid, and adaptable to future improvement under maintenance.

The work is divided into about 15 separate projects located at various widely scattered points within the borough, and gives employment to several thousand men The width paved varies from 30 to 50 ft. There are few curbs, and only shallow side ditches. It is expected that maintenance costs (which will be borne by the county) will be less hereafter than they were for the old street surfaces of dirt.

Adequacy and suitability of the type of surface selected were considered to have been proved by some 20 odd miles which were built previously under the first unemployment relief programs. A conspicuous example is a stretch of several hundred feet laid two years ago on 43rd Ave. in Long Island City, which has stood up well and is still in good condition in spite of being subjected daily to a heavy trucking traffic for which it was not designed or originally intended. On his visit to the work late in November, 1935, the writer found this and other pieces as smooth riding as many new pavements of several times their cost.

Still another factor in the selection was the adaptability of this type to the requirement that at least .65 per cent of the federal funds used on the project must be expended for labor, which proportion was made possible largely by the availability of both grits and cinders in large quantities at moderate prices.

Progress and Cooperation.—Work was begun October first and continued with very little interruption up to the middle of December. The average rate of progress was about one mile per day, some 40 miles being completed during the 40 working days to December 15. The principal delays during that time were caused by a shortage of trucks for the hauling of cinders and grits. Weather interfered but little. Unity of purpose and efficient cooperation between representatives of the WPA and the county maintenance forces is assigned as a major reason for the successful prosecution of the work.

Materials.—Most of the cinders are hauled from local points where they have been brought from various sources, and have accumulated in large quantities because of an inadequate market. The price, dumped on the road ready for spreading, has averaged approximately $1.00 per cu. yd.

The grits are a sort of a by-product of the extensive Long Island sand and gravel industry, being an in-between size, from ⅛ in. to ⅜ in., which are too large for

Cinders Roughly Spread, Nov. 25, 1935. Note piles of grits and screenings at side.

Spreading Cinders on 109th Ave. at 121st St., Oct. 24, 1935.

sand and too smal for gravel for most purposes. The average cost has b $1 75 per cu. yd., delivered at the roadside ready for se. . some cases where there was delay in securing g ne screenings have been used for the seal coat, a ap pear to give entire satisfaction.

The emulsion is a quick-breaking type, running about 60 per cent asphalt and designated as Type 3 in the specifications of the New York State Highway Department. It is hauled from a central depot in 1,000 and 1,200 gallon distributor trucks. The cost of all materials on the work done to date is about 35½ cents per sq. yd.

Procedure.—Where there is no major grading (which means on all but a very small part of the work) the first step is the truing up of the old surface to form a sub-grade. This is done by the WPA forces with pick and shovel, supplemented by power graders where necessary. When the sub-grade is ready, cinders are dumped in the middle of the road and spread by hand or machine, the depth depending on the character of the base. Where a fairly substantial old road surface is available as a foundation, 3 in. of cinders are used, but on poorer bases the thickness is increased according to the judgment of the engineer or supervisor in charge, the maximum being about 6 in. The final smoothing and leveling is done with rakes. Although this hand work is not as even as would be done by a properly operated blade grader, it is, on the whole, better than might be expected under the method used.

Pavement Laid in May, 1935, on Nelson Ave., Long Island City. Photo, Nov. 25, 1935. This street carries a fairly heavy traffic. The 4 or 5 ft. of slightly darker color along the curb is a plant mix of sand and asphalt.

The bulk of the cinders are of small size—probably less than ½ in.—but there are also numerous pieces 4 in. and larger, most of which are taken out by rake or shovel. In some instances, however, rather large cinders have been left in place, the roller being depended upon to force them down to proper level. This does not always succeed and sometimes results in humps. Furthermore, it is likely to increase the maintenance cost, for these large pieces in so thin a surface will probably loosen under traffic, thus starting pot holes and ravellings. Failure to remove them seems doubly short-sighted in view of the fact that the primary purpose of the construction is to supply jobs for unskilled labor.

Surface Covered with Grits after First Application of Emulsion, Nov. 25, 1935.

Emulsion at a temperature of 80° to 100° F. is applied at the rate of 1¼ gal. per sq. yd. on the loosely spread cinders, and immediately covered with about ¾ in. of grits cast on by shovel from piles previously dumped at the roadside. This leaves a slight excess of grits after absorbing that part of the emulsion which has not penetrated the cinders. The surface is then rolled once with a 6 or 8-ton roller which drives the grits in very well. Following the rolling, emulsion is again applied—this time at a rate of one gal. per sq. yd. Sufficient grits (usually about ½ in.) are spread to absorb the excess emulsion, and the job is finished by a cover of grits and another once-over with the roller.

Weather Limitations.—Work on each project is generally carried on one block at a time, with as many men as can be used practically within the area. Grading and cinder spreading are done in any kind of weather but emulsion generally is not applied when the temperature is below 35° F. Presumably it would be better if this minimum were raised to 40° F. Rain is not a cause of prolonged delay, for as a little moisture in the aggregate is an aid rather than a hindrance to penetration, it is unnecessary to wait for a complete drying of either grits or cinders. Work will continue during the winter, with the application of emulsion limited to periods when the temperature is 35° F. or higher.

Frost might be expected to cause trouble with a light pavement of this character on a sub-grade such as used on this work in Queens Borough; but the local engineers and others familiar with the two and three year old examples say such has not been the case. Presumably this is due to the character of the sub-grade material and the good natural drainage.

Conclusion.—It will be interesting to watch the behavior of these pavements over the next several years. That they will prove 100 per cent satisfactory is obviously too much to expect under conditions so far from ideal. But if a large proportion of them approximate the success of the few miles which have had a trial, they will not only provide the residents of the borough with badly needed street surfaces, but will demonstrate an economical and practical surface for many other light traffic roads and streets.

DEVELOPMENTS IN 1935 IN USE OF ROAD TARS

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THE year 1935 has been marked by gradual changes in the methods of using road tars. The tendency has been to produce a closed, tight surface to resist the action of present day traffic with its high speed on large sized low pressure tires. Tar grades and aggregate gradings have been standardized with that idea in mind. Provision has been made for the inclusion of a larger percentage of the smaller particles in the aggregates used as covering material. Construction procedure has also been revised to insure keeping a layer of tar seal at the surface of the road. Working along

Mix in Place

the same lines, the tar pre-mixes have been closed by the addition of finer aggregate so as to produce better wear resisting surfaces. All of this work has been done without sacrificing the typical skid-resistant characteristics of the tar road surfaces. The faces of the aggregate are exposed on the surface, and a sand paper, skid-safe surface is always formed.

Surface Treatments

There is a continuing tendency to use heavier tars for surface treatments. However, all of the following grades are successfully used.

Grade	Specific Viscosity, Engler 40° C.	50° C.	Float Test at 32°C. Seconds
TC-3	18-25		
TC-4	25-35		
TM-1		16-22	
TM-2		26-36	
TH-1			60-150
TH-2			150-210

With tars of the TC and TM grades, covering aggregates of the following gradings are recommended.

Sieve Size	Total Bitumen Passing 4-A (Mod.)	5-B (Mod.)
¾"	100	
½"	90-100	100
⅜"	40- 70	90-100
No. 4	5- 25	10- 30
No. 8	0- 5	0- 8

The seal coats should not be disturbed by dragging with a sled type drag, but broom drags may be used to distribute the cover uniformly over the surface.

Aggregates of the following gradings are recommended for covering material over tars of the TH grades which are applied hot. 4-A (mod) and 45-B (mod), graded as follows:

Sieve Size	Total Per Cent Passing
1"	100
¾"	90-100
⅜"	30- 65
No. 4	5- 25
No. 8	0- 5

The larger aggregate is used for the heavier tar applications. The cover should be rolled into the tar immediately after application while the tar is still warm.

Dragged Leveling Courses

Difficulty has been experienced by highway officials in attempting to do a leveling and sealing job with one application of tar. It is better practice to use a dragged leveling course to remove the inequalities of the old road surface, and finish with a seal coat of tar and appropriate cover. Tar TM-2 is generally used for both

Spreading Mix

Penetration Stone

the leveling course and the seal. The aggregate for the dragged leveling course should be 4-A (mod) or 45-B (mod) and the covering aggregate 5-B (mod). Usually about 60 lb. of aggregate per square yard and six-tenths gallon of tar per square yard will be needed for the leveling course. A seal coat of about two-tenths gallon per square yard and 10 to 15 lb. of cover should be used.

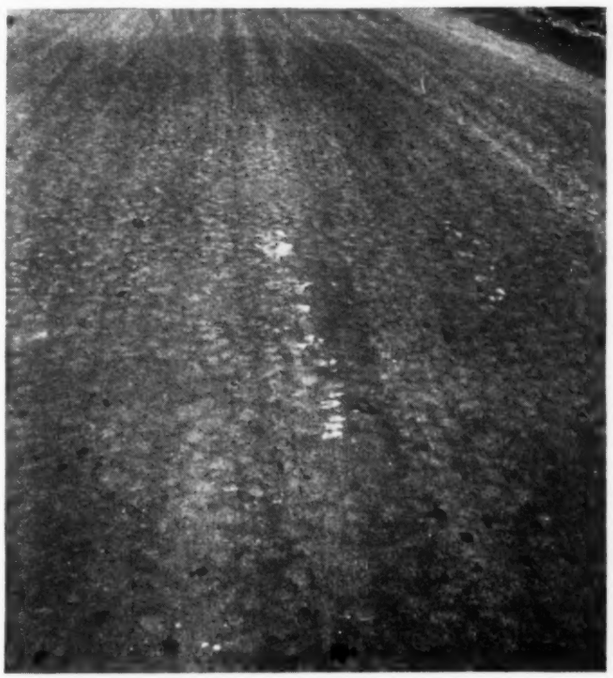
Mixed-in-Place Types

Here again the tendency is to use heavier tars so as to have them set up faster and provide for more rapid completion of the job. Hot tars TH-1 or TH-2 are now commonly used except in cold weather when TM-1 and TM-2 are used. 5-B (mod) is recommended for the choke stone and cover with either 3-A (mod) or 34-B, with gradings as given below may be used:

Sieve Size	Total Per Cent Passing 3-A (Mod.)	34-B
2″		100
1½″	100	90-100
1″	90-100	
¾″	40- 75	30- 65
½″	5- 20	
⅜″		0- 10
No. 4	0- 5	0- 5

After the mixing course has been rolled in the usual manner, choke stone is applied to fill the surface voids and thoroughly swept in place during rolling. Upon this is placed a first seal coat of one quarter gallon per square yard of tar, covered and rolled. The road may now be opened to traffic but should not be considered finished until it is given a second seal coat of one-quarter to one-third gallon of tar per square yard, covered with aggregate and rolled in place. Every effort must be made to thoroughly seal the surface of the mixed-in-place construction.

Rolling



Finished Surface

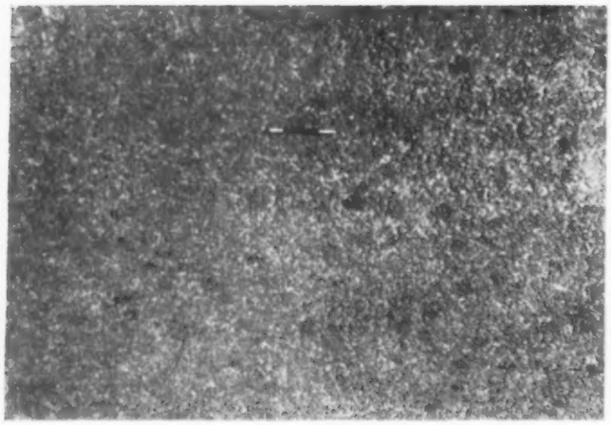
Penetration Macadam

Tars TP-1 and TP-2 with float tests at 50° C. of 100 to 160 seconds and 160-220 seconds respectively are used for penetration macadam construction.

Aggregates used are graded as follows:

Sieve Sizes	Penetration Course 2–A	2–B	Choke 4–A	4–B	Seal Coat 5–B (Mod.)
3″		100			
2–2½″	100	90–100			
2″	90–100	35– 70			
1–1½″	35– 70	0– 15			
1″	0– 15			100	
¾″			100	90–100	
½″			90–100	20– 55	100
⅜″			40– 75	0– 15	90–100
No. 4			0– 15		90– 30
No. 8			0– 5		0– 8

Two seal coats should be used, each thoroughly covered and rolled. Here again every effort should be made to obtain a tightly sealed surface.



Typical Non-Skid Tar Surface

Filled Macadam

A new type of penetration macadam involving the use of no liquid materials on the job has been used to a limited extent. Stone of the usual penetration macadam grading is spread to the required depth, usually about 4 in., and thoroughly locked in place by rolling. A fine graded, rather rich, tar pre-mix is then spread over the surface at the rate of about 100 lb. per square yard, and rolled into the open voids of the macadam. Some tar is squeezed out of the mix so that there is a bond between the mix and the penetration stone. The mix penetrates to a depth of about an inch and presents a tightly bound surface to the traffic. The construction operations are simple and a finished pavement is obtained at once without any loose aggregate on the surface. The coat is about the same as for the regular penetration macadam.

Gravel Mulch

In the construction of tar bound gravel mulch roads, the tendency is to use as heavy tars as can be readily handled. This will usually mean tars of the TM-2 grade, although TH-1 tars have been used in the south. Light seal coats are considered necessary on all gravel mulch jobs. From one to two-tenths gallon per square yard with a sand cover is general practice.

Pre-Mixes

Gradings of the cold mixes using tar binders have been closed by the addition of more fine aggregate and filler. The type of traffic using the roads now demands a tight, but non-skid surface, and the tar pre-mixes have been modified to meet this demand.

In addition to the mixes made in closely controlled central mixing plants, some cheaper mixes using pit or quarry run material have been made in portable plants of various sorts. Mixes of this sort usually require a liquid tar seal at the time they are laid.

There is an increasing tendency to use machines for spreading and finishing the pre-mixed material. Steel forms are also required by some highway departments.

Conclusion.—The year has been marked by efforts on the part of producers of bituminous materials, producers of mineral aggregates and users to agree upon aggregate gradings and combinations which will be most satisfactory to the user and produce the best highway surfaces for present day conditions.

The Romance of the Highway Bridge

Motorists traversing modern highways comfortably settled in deep cushioned seats, controlling almost without effort the power of a hundred horses in guiding the courses of their one to two ton vehicles, give but little thought as a rule to the construction features of roadways and structures over which they pass. Attention is on their own paths—pavement lanes bounded on the left by a glistening white traffic stripe and on the right by a smooth shoulder and a blur of shrubs, fences, trees and telephone poles.

With nearly a mile of roadway to be scanned each minute, between eighty and ninety feet per second, there is naturally little opportunity for, or interest in, appraising the character or safety of the bridges and trestles on the way.

The roadway may be elevated to afford free rapid passage over busy railroad yards, or may round a shoulder of a mountain side to cross at one hundred or two hundred feet above a rocky canyon, but as long as the road is reasonably smooth and wide and the curves not too sharp, the motorist will likely have little conception of the structures on the route. A $100 or $500,000 bridge is only a flash of gray-white railing.

To perhaps one of every thousand passing by, the high curved ribs and tall columns of a concrete arch or the long slender trusses of a steel bridge signify something more than a link between solid earth on two hillsides. To the thousandth man they are perhaps somewhat of a monument to the efforts of the designers who have spent hours over drafting tables, a pencil in one hand and a slide-rule in the other; of the laborers who have spent hours clearing, mucking, blasting, picking, shovelling their way down to solid foundations; of cement mills and rock plants grinding out tons of concrete materials.

He visions steel mills thousands of miles away shaping the steel; ships loading at east coast ports and unloading at fabricating plants for the cutting, punching, fitting and riveting; long truck hauls, partly over narrow mountain roads; then highlines picking heavy girders and trusses and easing them gently into place; surefooted steel workers fitting, bolting and riveting—all before placing the concrete deck and rail which to the average traveler, if noticed at all, is the bridge.

Economical bridge building requires a very considerable preliminary work in the way of foundation investigation, study in the matter of type selection and more work and study in the design of adequate members in order that the structures may be pleasing in appearance and practical in construction.

In so far as feasible, standards have been developed to reduce design costs and to secure uniformity in appearance. However, with new developments in materials available and improvements in fabrication continual changes are necessary to take full advantage of changing conditions. The policy of the bridge department has been one of conservative and progressive improvement rather than stagnant standardization in organization methods or design and construction practice.

In addition to new construction, an important phase of the department's work is the frequent inspection of the 3500 bridges on the state highway system. Repairs and minor improvements run upwards of a quarter million dollars every year.—*From a Publication of the Ohio State Highway Department.*

Safety at Important Highway Crossings Is Assured by Grade Separation Structures

DEVELOPMENTS IN DESIGN AND CONSTRUCTION OF CONCRETE PAVEMENTS

By W. F. TEMPEST

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THE use of concrete as a paving material has developed rapidly following the results of research. In highway construction, as in other branches of the construction industry, tests and field investigations are being continuously carried on to determine the best construction practices.

New Design Principles Applied to Actual Construction.—Changes in design and construction of concrete pavements have been based on thorough field studies and sound engineering practice. With the need for extension of highway improvement becoming greater each year, economical designs to meet the requirements of new highway planning are more necessary than ever before. One of the most significant developments in highway thought and practice, during the past year has been the direct application of new design principles to actual construction projects. Such designs have resulted in substantial savings and permit the use of high type pavement where otherwise it would have been impossible.

Engineering principles of selecting the most economical pavement design to fit the traffic have made possible the practical application of highway planning and the most economical expenditure of highway funds. The use of the so-called "standard" cross-section is no longer a fixed policy, but high type pavements are designed to fit conditions disclosed by field surveys and to assure a balanced program of highway improvement.

Increasing Safety on Highways.—Safety on the highways is now a live topic. Consideration is being given to surface finish to provide the most desirable coefficient of friction for stopping and for minimizing the tendency to skid while at the same time producing a surface that will assure a low vehicle operating cost. Safety has also demanded enquiry into economies of highway lighting and the relative visibility of pavement surfaces.

The need of separated traffic lanes for high speed traffic is now generally appreciated. A project in New Jersey demonstrated an unusual but effective means of salvaging the existing concrete and providing for separation of opposing lanes of traffic. This was accomplished by jacking one side of the pavement laterally to provide the desired separation in the center.

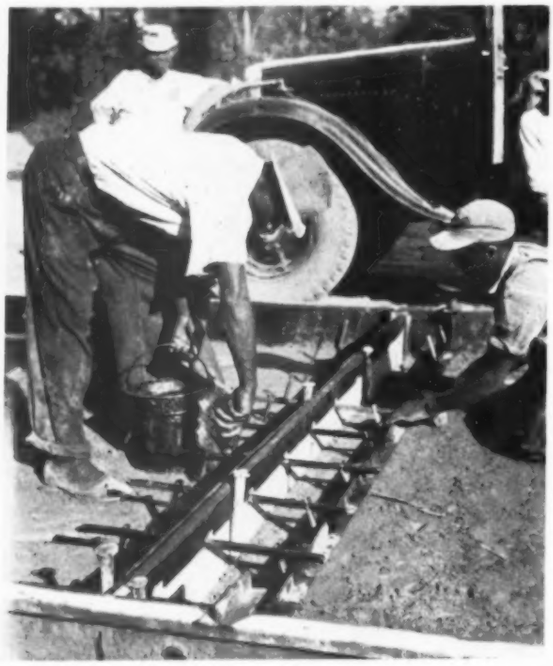
Expansive Joint Development.—State highway departments have more than ever taken an active part in initiating tests and bringing about developments in concrete construction practices. While cooperating with national organizations such as the Highway Research Board, they are at the same time seeking their own solution to problems within the state. A few states are now engaged in experimental work to determine the most economical and efficient type of transverse joint.

State highway specifications for 1935 indicated the demand for a non-extruding type of joint. The majority of the states definitely specified the type of joint

materials that would be acceptable. Seven states specifically prohibited the poured joint filler and two others permitted its use as a top seal only. For spacing transverse expansion joints the general practice has been to follow the recommendations of the United States Bureau of Public Roads; that is, ¾-in.-1-in. joints at not more than 100 ft. intervals, with intermediate contraction joints at not more than 30 ft. intervals.

Dowel Installation.—The use of dowels for the transfer of load across joints requires careful attention to secure proper installation. Equipment has been devised for holding the dowels in the true position while the concrete is placed. Some types of such equipment appear to accomplish the purpose for which they were intended and will be helpful overcoming difficulties that have occurred due to improperly placed dowels. It is now common practice to use ¾-in. round dowel bars 2 ft. long, spaced on 12-in. centers. Pipe dowels, and steel channels have also been used.

Vibration.—Vibration as a means of obtaining a densely compacted concrete for pavements has been tried



Careful Placing of Dowels Is Important. Greasing and an Adequate Space at the End of Socket Permit Free Movement

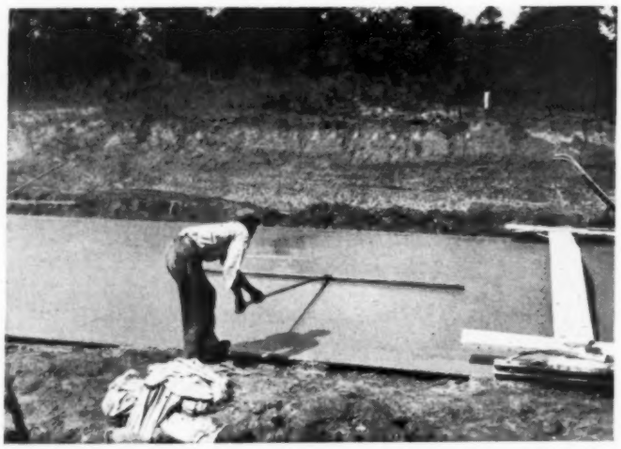
experimentally and one or two states definitely required its use at joints and along side forms. Others, while not definitely specifying vibration, intimate that they are considering it and may require its use at joints. The further development of this method of placing concrete should result in distinct advantage to concrete pavement construction.

Finishing Practice.—There has been little change in finishing practices and most states require close attention to surface finish with a minimum variation not to exceed ⅛ in. in 10 ft. When greater variations do occur, immediate adjustment or replacement is required.

As a check on the thickness of pavement slabs, 36 states require test cores to be taken. In the majority of these states a penalty is imposed for deficient thickness. In the state of Michigan, a penalty is also imposed when tests indicate pavement concrete of deficient strength.

Curing Methods.—Water curing remains the most satisfactory of all methods. Wet earth, hay or straw, or ponding methods are considered standard practice. For special convenience and where considered economical, other methods of curing are being tried. Those that appear to give best results are the materials that retain moisture for the longest period. These are the heavy burlap, cotton and felt mats. To be effective, it is necessary that these blankets be kept moist and in hot, dry weather, periodic sprinkling may be necessary.

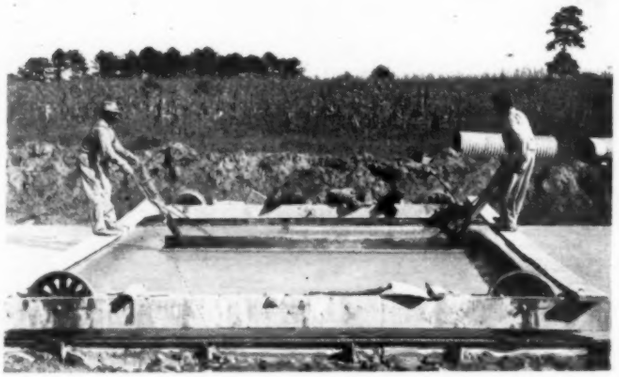
Test Specimens.—It is now a well-established prac-



Scraping with Straightedge Removes Excess Water and Weak Mortar Slush

tice to make test specimens of concrete as placed. These are stored alongside the pavement and cured in the same manner. At stated intervals these field test specimens are broken in a field testing machine. When the pavement has attained the required strength, as indicated by the test beams, permission is usually granted by the engineer to open the road to traffic.

Subgrade Studies.—The importance of good subgrade materials is becoming generally recognized. Many states are making a careful selection of soils for embankment. A classification is made of the characteristics of various



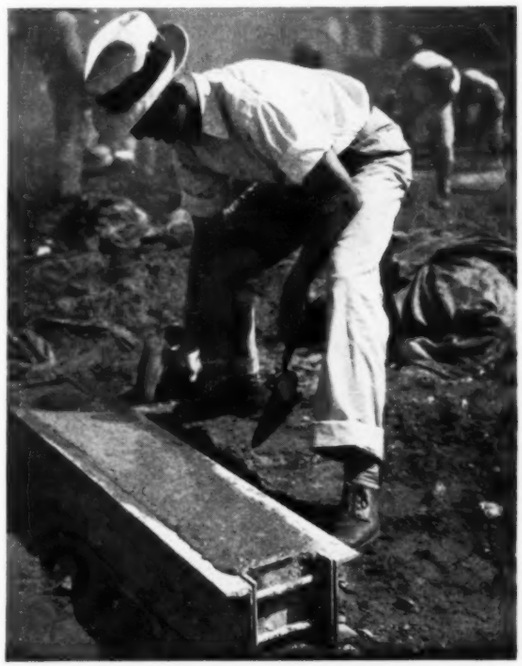
Longitudinal Float Irons Out Small Surface Irregularities

soils in the state and their suitability for subgrades noted. For this work many states have employed soils engineers and have established a special department.

Standard methods of testing now make it possible to determine the optimum moisture of the soil to secure the maximum compaction. This avoids general terminology in specifications and permits the engineer to make definite requirements.

Traffic Lanes.—With the increasing volume of vehicles on the highways and the greater necessity for

traffic control, the importance of marking lanes has increased. The advantages of permanent traffic lines have been recognized. Permanent markings can be placed with white concrete. This is made with white cement, white or selected sand and in some localities stone chips may be used. The white concrete marking strips are bonded to the pavement by placing them before the pavement slab has begun to harden. On rural highways which are not illuminated at night it is common practice to finish the surface with corrugated markings. This is accomplished with a stiff bristled broom. White concrete curbs are also being used for traffic guidance for increased safety and improved appearance particularly on special highways and boulevards.



Test Beams Are Made Under Same Conditions as Pavement

The greater interest in highway matters that has been evidenced by motorists, motor clubs and automobile manufacturers has encouraged those who have been continuously active in the highway field and has also provided an incentive to maintain high standards of highway improvement.

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Extent of Legal Duty to Safeguard Excavations

Where an excavating contractor knows that safeguards placed at excavations to avoid injury to persons, etc., have been disturbed by outsiders, he must use increased caution to make the safeguards more effective, according to a decision rendered by the Tennessee Supreme Court (8 *S. W. 2d,* 495).

A light and power company excavated a hole about 18 inches wide and 5 feet deep between a sidewalk and street curbing. Loose boards were placed over the hole, with dirt on top to weight them down. They were replaced by the company after having been removed by an outsider. The next morning the boards were found displaced again. A plank covering was then provided with a rock to hold it in place. Again the covering was removed and a pedestrian stepped into the hole. Her suit for damages was dismissed by the trial court on the ground that the company had done all that was required of it to guard against injury of anyone. But the Supreme Court reinstated the suit and ordered a new trial.

Method of Finishing Warped Surfaces at Street Intersections

An interesting feature of the construction of 0.40 mile of asphalt concrete pavement on Broadway in Fresno, Calif., was the method by which warped surfaces of paving, which occurred at intersections, were worked out by a combination of a standard finishing machine supplemented by the use of hand equipment. How this was accomplished is described by C. S. Pope, Construction Engineer, Division of Highways, in *California Highways and Public Works,* his description being based on notes furnished by District Construction Engineer R. S. Badger.

The width of pavement was increased by 10 ft. to a total of 62 ft., and included new curbs and gutters and drainage improvements.

All the asphalt concrete on this project, except the base course and that portion laid at street intersections, was spread with spreader boxes and finished with a 30-ft. mechanical finisher. The base course and street intersections were hand-raked.

Before paving was started, grades were painted on the pavement at 25-ft. intervals indicating the distance from existing pavement to the new grade. The 3-ft. 8-in. header was placed on its side and brought to a true grade with shims placed at 2-ft. intervals, the inner edge of the header being 30 ft. from the west gutter.

Holes were drilled at intervals of 4 ft. into the existing pavement at the outer edge of the plank and stakes driven into them. After the planks were brought to grade, they were securely nailed to the stakes. Planks, 3 by 8 in., were also laid flat along the gutter to carry one side of the finishing machine, and prevent damage to the concrete gutter.

The screeds of the finishing machine were divided into three 10-ft. lengths and were set to approximately fit the typical section. At the third point from the gutter there was a noticeable angle in the pavement before rolling. To eliminate this, a 3-wheel roller was passed over it twice before breaking down the asphalt concrete at the gutter, the cross-section of the completed pavement at this point having the appearance of a smooth curve.

At street intersections, the finishing machine was used to spread the asphalt concrete but the screeds were not changed to fit the changing cross-section at these places. All the intersections were warped surfaces and no two were alike, therefore it was considered impractical to change the screeds. After the finishing machine had passed over each intersection, the asphalt concrete was brought to its proper shape with a 14-ft. pole push float.

On account of its weight two men were required to operate the float. Two shovelers fed material in front of the cutting edge, keeping an even roll of the mix in front of the float, similar to a standard finishing machine screed.

For this type "B" asphalt surface the float secured excellent results, not only over the entire intersections, but at car track crossings and at junctions, when the day's work began.

After rolling the surface course sufficiently to produce a moderately smooth surface, and while the pavement was still quite hot, the smoothness of the pavement was checked with a 16-ft. straight-edge. Low spots were filled and high spots were rolled down as rapidly as they were found, and by thus spotting while the pavement was still hot, it was possible to eliminate a patchy appearance.

F. W. Howard was resident engineer in charge of the contract.

RECENT DEVELOPMENTS IN THE CONSTRUCTION OF ASPHALT SURFACES

By BERNARD E. GRAY

Chief Highway Engineer, The Asphalt Institute

A Finished Surface Treatment (0.35 Gal.) by Road-Mix Method on a Virginia Job

THE past year has seen a further marked increase in the use of asphaltic products for road and street construction, which has resulted from continued improved technique in the use of these materials both in the way of smoother denser surfaces and of increased resistance to skidding. Costs have declined alos as the result of using improved equipment, even though there has been a use of hand labor in many operations which are not technically justified. The increased efficiency of plant operations obtained through automatic controls and the use of more durable parts has led to a reduction in the number and time of minor delays with consequent increased output and reduction of overhead costs. Many of these details were mentioned in the January 1935 issue of ROADS AND STREETS, but notwithstanding the restriction regulations on public work the trend has continued during 1935 and promises to do so even more in the future.

In reviewing the several principal changes which have occurred during the past year, three appear worthy of more detailed comment. Perhaps they are not so much changes as trends in the direction of a different practice, and in one instance at least, a growing appreciation of possibilities. These might be listed as follows: (1) the trend toward doing surface treatment work more and more by road-mixing methods; (2) the increased use of cold-laid plant mixtures, and (3) and most important of all, the further development in soil stabilization.

Improved Light Treatment

We are so close to our every day work that we often overlook the gradual changes that occur. In 1934, Ohio accomplished several jobs by the road-mix method which previously would have been done as surface treatments. Virginia has developed an excellent technique in the same field, and in 1935 did the majority of its work by this procedure. The road-mix method was evolved originally as a way of laying a bituminous mixed pavement in very smooth fashion, particularly over old rough pavements that required reshaping and where variable depths were necessary. The early procedure was relatively crude in regard to dragging the aggregate, particularly in respect to the unbalanced relation between asphalt and aggregate. This spotty effect was soon apparent and was partially overcome through more careful aggregate grading and the use of asphalt products having higher initial viscosity and a faster rate of curing. However, the present day success was not attained until the development of road-mixing machinery made possible the uniform spreading of aggregate and its rapid thorough mixing with the bituminous materials. It is hardly possible to overstress the service rendered

Road Mix Equipment Adapted to a 0.5 Gal. Surface Treatment in an Ohio Job.

Rolling a 0.35 Gal. Treatment on a Virginia Road Job

by equipment manufacturers in so closely meeting the needs of this situation, especially when many arbitrary regulations have tended to discourage them. So efficient is this equipment that it has been found adaptable to mixing much smaller quantities than had been previously possible, so that with as little as 30 lb. of aggregate per square yard and 0.30 gal. asphalt, complete uniform coating and spreading is possible.

Under normal surface treatment procedure, the asphalt was applied first and then covered with the aggregate. Where there were uneven areas in the old road surface or where the crown was excessive, certain disadvantages were had, the principal ones being the tendency to accumulate excess bituminous material in the depressions and at the edges so that when the aggregate was spread a non-uniform coating occurred. The road-mix method is to apply a tack coat to the surface (as light as can be made) and rarely exceeding 0.10 gal. per square yard. Suitable aggregate of appropriate size, according to amount of treatment, is then spread on one-half of the roadway width at a uniform rate per square yard. This is followed by the application of the asphaltic material, and immediately thereafter by the road-mix equipment. Due to the constant ratio between aggregate and asphalt obtained by this method, varying depths of the mixture can be placed having a uniform surface texture, while the channel sides of the mixing equipment give a sharply defined edge to the resurfacing which gives it the appearance of a plant-mix job.

There is also the advantage to passing traffic in that the aggregate is coated in such a way that there is no pick-up. Only one mixing of the aggregate is required for the ordinary surface treatment rates of application. The rate of treatment may vary from 0.30 gal. to 0.70 gal. Finally a very light seal coat can be given (not over 0.10 gal.) using sand for cover, so that an extremely dense durable surface may be obtained. This provides a thin rich top yet with a uniform distribution of asphalt and aggregate underneath in a rather lean mix, which procedure eliminates the alternate fat and lean spots which are often inescapable in ordinary surface treatment procedure, particularly in retreatment work over old surfaces.

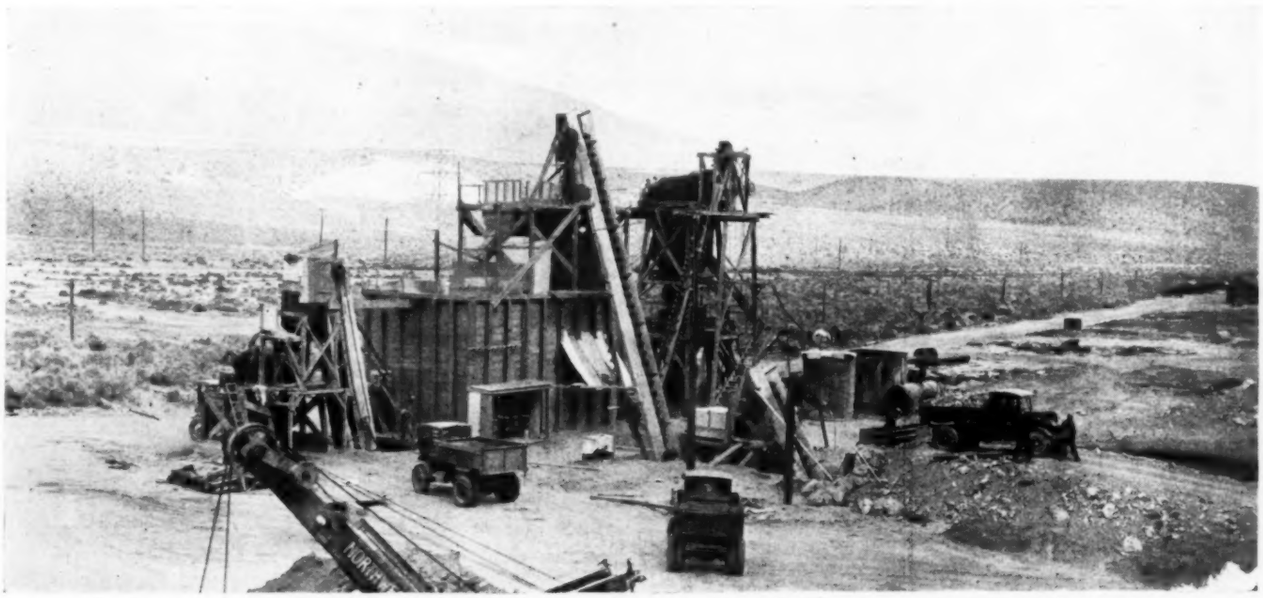
Cold-Laid Plant Mixes

The second trend observed is the greater use of the cold-laid plant mixes and which has received much stimulation because of the excellence of road-mix surfaces, particularly in regard to smoothness, coupled with an appreciation of the greater durability and quicker setting of surfaces where plant-mix methods were employed. Plant manufacturers have been very active in improving their equipment with various automatic controls so that the resultant mixtures follow uniformly the standards set by the laboratory. In many cases production has been increased as much as 100 per cent, which has made it often possible to produce plant mixtures at costs little if any greater than for road-mix, particularly where the job is of substantial size.

The cold-laid plant mix field is rather broad and covers a number of proprietary types as well as those generally familiar in open specifications. In general, however, they all come within five principal classifications, as follows:

1. Coarse graded aggregate mixtures, liquefier type.
2. Coarse graded mixtures, cutback type.
3. Coarse graded aggregate mixtures, emulation type.
4. Dense graded aggregate mixtures, cutback type.
5. Dense graded aggregate mixtures, blended type.
6. Rock asphalt.

Group 1 is probably most widely known and one of the oldest of the cold laid mixtures. Originally named after Dr. Amies, it has been in use for nearly 30 years and has been placed with success on a wide variety of foundations. While not the words of the original pat-



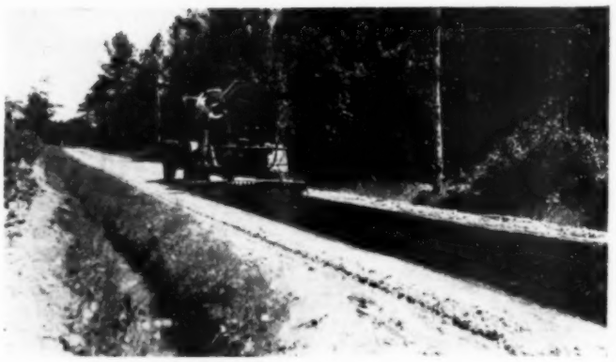
A Plant Set Up for Cold-Laid Mix Job in California

ent, the basic principles is the priming of a macadam aggregate with a kerosene type of distillate, after which a hot asphalt cement of approximately 100 penetration is added, together with a small amount of hydrated lime. The aggregate is previously dried but at the time of mixing is at a temperature not exceeding 125°, while the asphalt is between 250° F. and 325° F. The liquefier serves two purposes—first, killing the dust around the aggregate itself so that adhesion of the asphalt is facilitated, and second, by slight dilution of the asphalt to delay its setting so as to permit transportation and spreading of the mixture in cold form. The hydrated lime also aids in obtaining this friable condition. The time needed between mixing and spreading before setting will take place is controlled by the amount and kind of distillate employed. There are variations, such as substitution of other fillers for lime, including powdered asphalts, or combination therewith, but the basic principle is the same.

Group 2 is an outgrowth of the macadam aggregate road-mix method with cutback asphalts where it is desired to have the mixture set up very quickly or where a more perfect aggregate grading is desired. A cutback asphalt is employed having a relatively small percentage of distillate, so that evaporation will take place quickly between the time of mixing and spreading, and thereafter the surface can be immediately rolled. While the so-called cold patch mixtures are a variation of this type, the usual method calls for the use of two grades of cutbacks, one a medium-curing type such as the M.C.-1 grade which is used for a primer, followed by the rapid-curing grades of R.C.-3 or R.C.-4, the latter being used where immediate laying after mixing is contemplated. The principles involved are somewhat similar to those set forth under Group 1.

For the emulsified asphalt for cold-mix, outlined in Group 3, there are two principal varieties, one where the aggregate is dipped into a tank of emulsion and kept immersed until thoroughly coated, and the other where a combination of hot asphalt cement and cold emulsified

A Finished Road in Florida—Cold Laid Plant Mix



A Final Surface Treatment May Be Desirable After Stabilization

asphalt is made with the aggregate in a regular asphalt plant. The immersing method is used principally for making binder-course mixtures upon which a seal coat of some kind is placed, while the second method is used for both binder and wearing course mixtures.

One of the advantages of the immersion method is the ability to use wet aggregate, but it is desirable to have the aggregate uniform in this respect so that a uniform coating will be obtained. Experiments have been made in adding cold emulsified asphalt to a hot aggregate, which results in immediate change of a large part of the water to steam leaving the aggregate coated with a soft asphalt film, and in which form it may be spread and compacted after cooling. There are other ways in which emulsified asphalts are used which will be described later.

The fourth group consists of dense graded aggregates with cutback asphalts and is also an outgrowth of a road-mix type. The dense graded aggregate road-mix was started originally in the west, using gravel aggregates and road oil, and was improved further by using medium-curing cutbacks because of their greater resistance to capillary moisture. Finally, the mixtures were made in a plant so as to better control grading and to utilize a still heavier asphalt product, at the same time employing the spreading and finishing operations which had produced such exceptionally smooth surfaces under road-mix methods. The use of such plant mixtures has gradually spread east and is universally adaptable where dense graded aggregates are available. They provide for the use of the complete range of sizes from gravel pits or from stone quarries, and oftentimes a relatively soft aggregate, which would not be adaptable for coarse graded mixtures, will prove quite satisfactory for dense graded mixtures under medium-heavy traffic. From the pit and quarry owners' standpoint the method permits the utilization of the finer sizes which often tend to accumulate as a waste product.

Group 5 is probably one of the least understood of the cold-laid types and yet the principles which underlie the several processes are eminently sound. Instead of setting the mix through loss of liquefier, distillate or water, as in the previous groups, the mixture sets from increasing the hardness of the binder by blending and amalgamating two or more separate grades of asphalt cement.

While there are several ways of doing this, which are distinctions rather than differences, the principle is always the same. In one of the best known varieties, the aggregate is first coated with a soft flux or heavy oil, after which an asphalt powder having a penetration of less than 5 is added. For a time after the mixing, this powder is relatively inert so that the mix is extremely pliable, may be transported, manipulated and

placed on the road almost as though it were an oil mix. Gradually the powder amalgamates with the flux and the resultant product hardens until it is similar to a binder grade of asphalt. By varying the proportions any degree of hardness can be obtained, although the usual range is around 125 penetration, and the time between mixing and hardening can be controlled. All types of sheet asphalt and asphaltic concrete may be made by this method.

Grading Road So It Will Drain Properly, Preparatory to Soil Stabilization

In place of the powdered asphalt, one variation of this method calls for the aggregate to be first coated with the hot flux, then with a hot asphalt of approximately 20 penetration, followed by another coating of soft flux. Thus for a time there is a sort of sandwich of two layers of asphalt of different consistencies around the aggregate, which gradually amalgamates and produces a binder of the desired characteristics. In another method the mixture is made by combining a hard asphalt powder with an emulsified asphalt, and sometimes a light distillate is used for priming purposes as well.

In still another method, the flux and powdered asphalt are first blended by heating not to exceed 225° F. so as to produce a final product of about 200 penetration. It is believed by this method that certain qualities are obtained which make for a very dry non-skid surface, yet having a long life due to presence of a relatively soft asphalt cement. The aggregate and asphalt are mixed in the usual manner in a pug mill, and just before dumping there is a small quantity of water added which fluffs the mix and enables it to be shipped and spread in cold form.

Group 6 includes the well known sand-rock and lime-rock asphalts, which are produced by crushing and grinding asphalt impregnated sandstones or limestones. Asphalt cement is added to limestone rock asphalts as a general rule to give the correct per cent of binder. Sand-rock asphalts are usually mined in the strata which already contains the correct amount, but recently experiments have been made by adding emulsified asphalt to lean sand-rock asphalts to make up the deficiency, and which process appears to have considerable merit.

In most instances these various mixtures are made as hot mixes, then transported and laid cold, but there are varieties, however, where the mixture is made and shipped cold, then later heated just before placing on the road so as to accelerate the blending. While there is some difference of opinion as to the longevity of cold-mix surfaces as compared with hot-mix surfaces, there can be no question but that in many instances the ability to transport and place cold mixtures has decided advantages, and particularly in view of the fact that the cost of manufacture has steadily declined so that in many instances the cost in place is little if any more than the road-mix surfaces. In this discussion no attempt is made to evaluate the different processes, but simply to outline the different methods employed.

While comment has been made in previous articles concerning the use of mechanical spreading and finishing equipment, it may not be amiss to note the desirability of such procedure again at this time. Whereas in former years specifications were written around manual spreading and finishing, with an optional use of equipment, today the whole trend is for requirement of the equipment with manual finishing permitted in restricted situations only. With either hot or cold plant mixes, all spreading, finishing, and compacting should be done with machinery wherever possible, because it is not only productive of superior surface results but is cheaper as well.

Soil Stabilization

Finally, and most important is the matter of soil stabilization, a growing development which must engage the attention of every engineer who is looking ahead. The ability to utilize ordinary soils already in place on the road either as a foundation for a wearing course or as a surface in itself is a goal toward which all are striving. It is well known, although not widely appreciated, that any soil when at optimum moisture content can support almost any highway load without deformation. If some way could be found whereby this condition would be made permanent the year around; or putting it another way, if the soil could be so treated that it would have no volume change throughout the year, there would be no need for any pavement other than a very thin wearing course to take care of abrasion. All too long this question has been dismissed with the statement: "That's a bad soil," and then thousands of dollars have been expended to cover it with a heavy pavement and to fight the condition rather than to overcome it.

Road Surface After the Intimate Coating of Soil with Asphaltic Material. Some Further Blading May Be Required Under Traffic.

It is pertinent to ask why one soil is a bad soil as contrasted with another. As a matter of fact, some of those most condemned have the highest degree of supporting power when the right amount of moisture is present. The challenge to engineers is inescapable that they should be able to solve this problem, and that there must be some way to fix this right amount of moisture or its equivalent, and thus obtain the advantages already inherent in the earth itself.

Most attempts so far at stabilization involve modification of the soil by admixture of granular material so as to change its mechanical structure, and in many situations this procedure should be continued as it is economically desirable and the objective can be attained

most cheaply by this method because of ready availability of modifying aggregates. Various salts, both hygroscopic and crystalline, have been added to these modified mixtures with view to maintaining a more uniform moisture content. Much research has been done in this field and the work so far accomplished has had considerable merit, particularly in the establishment of durable foundations. The principle involved is to more nearly maintain the optimum moisture condition, retaining moisture during the dry season and repelling additional moisture during the wet seasons.

The use of asphalt products is made from a different standpoint, with view to replacing the moisture with a bitumen of appropriate kind and amount, not only so that moisture thereafter is excluded, but that in its place is substituted a binder of greater adhesive power and less volume change. With sandy soils this is relatively easy and such procedure has been followed for nearly thirty years in California and other western states. Fresno County, for example, alone has over 3,000 miles of such surfaces where asphaltic oils have been gradually blended into the soil until a depth of as much as 12 in. has been obtained, and which acts exactly as a pavement. In recent years much work has been done in Florida and adjacent southern states in mixing the beach sands and liquid asphalts. Something like 200 miles of main state highways in Florida have been constructed by this method, the usual depth of the mixture being approximately 6 in.

As the soil particle sizes become smaller, however, as with clay and silt soils, the difficulty of completely coating the particles becomes much greater. Several methods are being developed for facilitating this process. With emulsified asphalt, for example, the procedure is to dilute the emulsion so that on application to the soil a degree of plasticity is obtained so that the emulsion is diffused completely through the mixture before breaking. Upon drying out, the film of asphalt, while of microscopic thinness around each particle, is yet enough to destroy the colloidal properties of the clay so that thereafter it will not absorb water, have relatively little volume change and consequently retain the supporting power it would normally have at optimum moisture content. Because of the high penetrating powers of kerosene distillates, medium-curing cutback asphalts also have the ability to mix with many finely divided soils and to coat the minute particles so that the mixture afterwards will resist moisture. Asphaltic oils are often used to produce satisfactory results.

It sometimes occurs that a method or grade of asphaltic product applicable to one soil will not work elsewhere even though the soil appears the same. The very way in which the soil is formed may have a marked bearing on its behavior. For example, one formed in the dry warm climate from a granite ledge will be of one character, because the breaking down has resulted from the differential expansion of the several constituents of mica, quartz and felspar, while if the same type of granite ledge is broken down to form soil in a wet cold climate, the latter will be quite different because the water and frost action will have formed the particles in different shapes and sizes. Then too, some minerals have a greater affinity for asphalt than others and thus if the surface area of a particle is composed largely of ones having such affinity, it will resist water action; while if the reverse is true the asphalt may be stripped away. Yet even in the second instance, if the soil is first treated with some other agent such as a potassium-base soap solution, this preference for water may be changed to a preference for asphalt and the mix become a success instead of a failure.

An inspection was recently made on a long project where a variety of bituminous mixes had been made with the natural graded soil using several kinds of asphaltic products, and different rates of application. After one winter the surface evidenced every degree of stability from dust to mush. About one-half of it was in excellent shape and the engineer who had directed the work commented upon it somewhat ruefully, "Now if I only knew how to do it over again." However, this kind of result is to be expected in any new field, the important thing being that success has been achieved once and therefore it can be reproduced. From the experiments of today will come the established technique of tomorrow, and with the rapid additions to knowledge now being made it is only a question of a short time before radical changes in highway design are certain to occur.

It is not only stimulating to the engineer but is of the utmost importance to the taxpayer to consider the possibilities inherent in the utilization of natural soils

Two Sections of Clay Soil Stabilized with Asphaltic oil. Foreground Fair; Background Good; Rates of Application Different

to produce both surfaces and foundations at but a fraction of what has been expended for pavements.

Conclusions

1. The trend toward greater utilization of equipment, especially in the finishing operations, is evidenced not only in pavement work, but is also extending to the application of light surface treatments. The results are not only better but lower in cost as well.

2. The many advantages of road-mix procedure, particularly in spreading and compacting, are being obtained in combination with the careful proportioning obtainable in plant mixing, through the greater use of cold-laid plant mixtures. This is a field which should attract greater attention from pit and quarry operators.

3. The stabilization of natural soils by appropriate treatment with asphalt products offers unlimited possibilities, both in the strengthening and waterproofing of subgrades, thus reducing pavement thickness and joint failures, and in actual surfacing of many plain dirt roads so that no additional pavement will be required. It is hard to over-estimate the value of further studies in this field.

A Finished Cold Laid Plant Mix in Nevada

Austria's Gross Glockner Highway Completed

A bulletin of the U. S. Department of Commerce reports that the Grossglockner Highway, one of Europe's foremost engineering feats and on which construction has been carried on for 5 years, has been completed and was officially opened to local and international traffic August 3, 1935.

This road crosses the Grossglockner range of the Alps at an elevation of approximately 8,000 feet, more than 2,000 feet higher than any other road in Austria. It is reported to have cost 25,800,000 schillings (at present exchange about $4,902,000). Recently 1,600 men have been employed on the work. As high as 3,200 workmen were employed at the peak of activity.

This highway is about 95 miles south of Salzburg and crosses the Italian frontier about 20 miles south of the Glockner pass. While providing communication facilities between the province of Salzburg on the north and the province of Carinthia on the south, it will also greatly shorten the international traffic between points in northeastern Italy and southern Germany.

In addition to many other desirable features, a branch road about a mile in length has been constructed to the summit of the famous Edelweiss mountain. Previous to this construction it was necessary for seekers of the rare and inaccessible Edelweiss blossom to make their tortuous journey entirely on foot.

Economies in Timber Bridges Fire Hazard Not Serious

In Wyoming, where a combination of great distances and small funds burdens the highway engineer with special problems of economy, the development and use of timber structures has been carried farther than in most states where there are more dollars per mile of road. Some interesting comments which may be of value to engineers in other localities are contained in a paper, "Problems in Bridge Design and Construction in Wyoming," which was presented at the Highway Conference at the University of Colorado by Ned Williams, Assistant Bridge Engineer, Wyoming State Highway Department, Cheyenne, Wyoming. Following is an excerpt from that paper:

The use of treated timber for a large number of bridges in Wyoming has definitely resulted in economies which have made available money for use elsewhere in the state highway system. Since 1923 a saving of over $3,000,000 has been effected by the use of timber structures under certain conditions, and this has made possible the construction of approximately 300 miles of graded and oiled roads which would be yet unimproved if these bridges had been constructed of more permanent materials. It is not claimed that timber bridges are economical for any and all locations, or that they can be constructed to look as well as those of other materials. However, inasmuch as their life expectancy in this climate varies from 30 to 50 years and the immediate need for an improved highway system is great, timber bridges must often be chosen in preference to the more nearly permanent bridges of concrete and steel. The Wyoming Highway Department has not found fire hazard for timber structures to be an important factor. During the past five years the department has built more than 20,000 lineal feet of timber bridges, and only three bridges have been destroyed by fire, the total length of these being slightly over 100 feet. It is only fair to state that two of these were fired by our own maintenance men who were burning weeds. A great deal of study has been given to the determination of the most suitable type of wearing surface for these structures. We have decided that an oil-mix gravel wearing surface is more suitable for timber bridges than asphalt plank where approach roadway surface is oiled.

▼

Praise for New York's Street Cleaners and a Plea to the Public

[*Editorial in New York Times, November 23, 1935*]

In its latest survey the Committee of Twenty on Street and Outdoor Cleanliness distributes praise and criticism with an even hand. Never before, it declares, has the work now entrusted to the Sanitation Department been so well performed. That is a merited compliment. With the means at their disposal, Commissioner Hammond and his aides have wrought wonders. Nevertheless, some streets, at some times of the day, still "look like those of a frontier town." That they grow filthy again so soon after they are swept is surely not the fault of the sweeper. The public is largely to blame. The new wire baskets on the corners are a great help, and psychologically an improvement over the old covered receptacles, which somehow do not attract papers intended for the discard. But brooms and baskets are not enough. The habits of slovenly folk need to be changed so that they will refrain from littering up the streets the way they do today.

Brick Pavement on Monroe Avenue, the Main Street of Grand Rapids, Mich., Completed November, 1935, *Illustrating the Use of Light Colored Brick for Permanently Marking Crosswalks.*

BRICK PAVEMENTS— RECENT PROGRESS

By GEORGE F. SCHLESINGER

Engineer-Director,
National Paving Brick Association

THERE have been developments in the manufacture and use of paving brick in recent years that have been of major importance in improving the quality of this long established type of pavement and in adapting it to the requirements of present day traffic. In this report there will be brief descriptions of the various items and reference is also made to Dean Marston's study of the service life of brick pavements and to the reconditioning by relaying of old brick pavements in the work relief programs.

Laying Operations in Widening Existing 18-*Foot Concrete Pavement on West Jefferson Street in Springfield, Ill. This Pavement Was Widened Last Year with a Concrete Base to* 40 *Feet and Resurfaced with Brick.*

Vertical Fiber Lug Brick

In this variety of vitrified paving brick the wire cut, anti-skid side is in the surface and the sides and ends are provided with lugs which insure the complete filling and sealing of the joints. Since new manufacturing methods of recent years have made this type commercially practical they are being used in increasing proportions. In 1934 they constituted 63.2 per cent of the total shipments.

Varieties

Since 1921 the Division of Simplified Practice of the U. S. Bureau of Standards, through a committee composed of representatives of engineering and technical societies, has annually recommended a standard list of sizes and varieties of paving brick.

Following is the current recognized list:

Type	Size—Depth-Width-Length	Pct. '34 Shipments
Vertical fiber lugless	2½x4 x8½	9.7
Vertical fiber lugless	3 x4 x8½	5.9
Repressed lug	4 x3½x8½	9.6
Vertical fiber lug	2½x4 x8½	19.1
Vertical fiber lug	3 x4 x8½	37.5
Vertcial fiber lug	3½x4 x8½	6.6
Total of 6 varieties recognized		88.4%

It will be noted that all varieties of wire-cut-lug brick have now been eliminated, having been replaced with the vertical fiber lug brick type of three depths—2½

in., 3 in. and 3½ in. The percentage of total shipments of the new recognized list is the greatest, with one exception, since the first list was adopted in 1921.

De-aired Paving Brick

The commercial application of the evacuating or air-extracting process of producing paving brick is also an innovation of the past few years. Sufficient experience has been had with de-aired paving brick to justify the conclusion that with proper production methods a new paving unit of greater strength and density which retains all the old advantages of regularity of shape is now available to the highway engineer. Standardization of physical requirements and tests are expected to result from the cooperative investigation now under way and participated in by the U. S. Bureau of Public Roads and the National Paving Brick Association.

The investigation includes a comparison of the quality of both the de-aired and unde-aired brick from nine plants located in Pennsylvania, Ohio, Indiana and Illinois. A sample representing each of three degrees of burning (dark, medium and light) and from both de-aired and unde-aired stock has been selected from each plant. One hundred brick of each grade and type will be tested by the Bureau of Public Roads and 80 brick of each grade and type by the Research Bureau of the National Paving Brick Association located at the Ohio State University Engineering Experiment Station. Samples were selected jointly by representatives of the Bureau of Public Roads and the National Paving Brick Association.

Each of the six samples from each plant will be subjected to the following tests:

(1) Standard rattler tests, obtaining in each case the loss in weight of each individual brick as well as the average loss.
(2) Standard flexure tests.
(3) A surface hardness test, using the device described in Public Roads, July, 1929.
(4) Standard Deval abrasion tests.
(5) Los Angeles rattler tests.
(6) Absorption tests, using samples of rattled brick.
(7) Determinations of "bulk specific gravity."
(8) Impact tests on whole brick, using a pendulum impact machine, with specimen supported as a cantilever.

Bed Course or Cushion

The trend is toward the increased use of the bituminous mastic cushion although untreated sand, stone screenings, granulated slag, or sand-cement still have their proponents. The specifications for mastic bed of the Vitrified Brick Pavement Specifications of the American Society of Municipal Engineers are typical of those in general use.

During the past year it was considered desirable, particularly for brick resurfacing over worn concrete, to develop a bituminous mastic cushion with greater stability and crack bridging qualities. This required an increase in bitumen content in a mixture that could be prepared by the contractor without elaborate equipment or extensive experience. A specification for this type of mastic was developed for the National Paving Brick Association by the Chicago Testing Laboratory which has an ultimate bitumen content of about 10 per cent and has the characteristics of a fine aggregate bituminous concrete. Powdered asphalt and suitable flux which amalgamate quickly are used. Excellent results were obtained in the laboratory and it is expected soon to have further experience with this cushion material in actual construction. There is of course some increase in cost.

Construction View Showing "Kettles" in Which the Asphalt Filler Is Heated, Tandem Roller, Gravity Roll-Conveyors Bringing the Brick to the "Droppers" Laying Brick, Trussed Cushion Templates on Disc Wheels with Compensating Carriages for Striking Off the Mastic Cushion Course.

Filler

The surface removal method of bituminous filler application introduced several years ago has now become practically universal practice. The requirements for this method as at present practiced are covered in the A. M. E. Brick Pavement Specifications. The Research Bureau of the National Paving Brick Association is experimenting with a device for applying the separating agent which is expected to be an improvement on present method. It consists of a cast iron roller covered with a sponge rubber shell with a storage tank and compressed air feed.

Investigations by Messrs. Stinson and Roberts, reported to the Highway Research Board, indicated that the coefficient of friction, both rolling and sliding on "a vertical fiber brick road, free of asphalt filler" was practically the highest of any of the types that were included on their tests. Observations made by them on the same pavement during the second and third years after completion indicated a measurable reduction in friction. According to their report, this was due to the asphalt progressively exuding from the joints and covering a considerable percentage of the surface. The

Removing Surplus Asphalt Filler from the Surface of the Brick Pavement Which Had Previously Been Sprayed with a Calcium Chloride Solution Using the Pressure Tank Shown on the Right. This Produces a Clean Anti-Skid Riding Surface.

National Paving Brick Association recognizing the important bearing of filler exudation on the anti-skid properties of the brick pavement has made an extensive investigation in its Research Laboratory with a view of developing a filler that will be less exuding in character than the asphaltic material now in general use. Laboratory tests simulated service conditions with brick pavements having joints filled with various materials, constructed in panels and subjected to electrical heat on a definite schedule.

Field Tests

The most promising of the fillers developed in the laboratory will be tested in actual service in a brick pavement recently constructed under the supervision of the U. S. Bureau of Public Roads and the Ohio Highway Department on Ohio Route No. 31, the Columbus-Athens Road in Hocking and Fairfield Counties. There are 15 sections of brick pavement each about 500 ft. in length in which different varieties of fillers will be used. Following is an outline of tests that will be made and observations that will be recorded.

1. Exuding of filler.
2. A comparison of traffic effect on a brick surface course. A large number of trucks carrying five or more tons use this road to transport coal to Columbus. These trucks travel light going to the mines and use the other lane going north when they are loaded. The two lanes can easily be analyzed to determine the effect of heavy loads.
3. Temperature gradient through brick-cushion-base and subgrade and a determination of the protective effect of brick surface courses on a concrete base. No factual information is available on the temperature gradient through the various parts of a brick road.
4. Tractive resistance of motor vehicles on brick surfaces as related to the amount of exuded filler. This will be a continuation of an investigation by Professors Stinson and Roberts of the Mechanical Engineering Department of Ohio State University as reported to the Highway Research Board.
5. Determination of whether separating agents affect the adhesion of the filler material in the joints. In connection with the use of "plastic sulfur" a new separating agent (an oil-water emulsion) will be tried. Data relative to the effectiveness and cost of using this material will be obtained.
6. A study of the moisture proof qualities of a surface course of brick.
7. A record will be kept of the temperature of the heating kettle and occasionally of the temperature of the filler as poured from buckets. The surface of the filler will be chilled with water at several points and the effect of shrinkage in the joints on exuding noted. At various points brick will be removed from the finished pavement to note the penetration of filler in the joints.
8. It is proposed to devise a test to determine the amount of stress and impact that is absorbed by a brick surface course. The details of this test have not yet been fully worked out and it will be preformed first in the laboratory on brick pavement panels.

Base Courses and Monolithic

The requirements for foundations or base courses will vary according to local conditions of climate, subsoil and traffic loads. In the southern section of the country, vitrified brick surface courses are successfully used on such foundations as natural sand, chert, gravel, crushed stone, slag, and Florida lime rock. Brick pavements have, of course, given excellent service on macadam, black base and concrete.

Concrete is the material commonly used as a foundation course for city streets and heavy traffic pave-

Installing Thermo-Couples to Determine Sub-Grade Temperature Gradient on Brick Experimental Road Constructed on Ohio Route 31 This Year. Similar Thermo-Couples Will Be Installed to Determine the Temperature Gradient in the Brick Surface Course, Cushion and Concrete Base.

ments. With a brick surface course, the great majority of engineers prefer a relatively lean mix of concrete for the base—thus reducing the expense and, at the same time, securing more desirable results. A concrete of comparatively low cement content is favored because it will expand and contract less with changes in temperature and moisture. As its tensile strength is less, cracks that form are more dispersed, have greater resistance to load stresses, and seldom affect the surface. The brick surface also prevents serious progressive increase in cracking. If it is decided to use a richer concrete,

the base course design in a number of recent projects has provided for crack-control, with expansion and contraction joints. If a poured or pre-molded expansion joint is used in a concrete base, it should extend to the top of the brick surface course. Experience indicates, however, that contraction joints only, at intervals of 25 to 40 ft. depending on conditions, will meet all requirements. A plane of weakness is recommended in the brick surface over the base contraction joint formed by inserting 3-ply building paper (or similar material) in a row of brick in order to break the bond and concentrate the crack in one joint.

In connection with a discussion of joints in concrete bases it would be apropos to mention that the monolithic type of brick pavement shows some signs of revival. In this design the brick without cushion are laid directly on the green concrete base and filled with cement grout. On an experimental brick road on Ohio Route No. 43 in Carroll County, constructed in 1933, a section of monolithic was included. The construction included a longitudinal center and 1 in. transverse expansion joints at intervals varying from 50 to 100 ft. A smooth surface was secured and the section is now in perfect condition. Further projects of this design are contemplated. It would seem certain, however, that if the monolithic type should again receive favor, the present standard brick pavement, which has proved its merits, will continue to be the recommended type for general use, particularly for municipal streets and resurfacing.

Salvaging and Relaying

While it would be no exaggeration to say that many hundreds of brick pavement 25 years or more old have been relaid in the last decade, this type of recondition

Relief Workers Cleaning Salvaged Brick on Dodge Street, Omaha, Neb., Which Were Relaid After 32 Years of Service.

attained unprecedented proportions in the federal aid program of work relief. Engineers who have decided to salvage and relay the brick—either utilizing the old base or on a new foundation—have been surprised at the results. Care and skill used in the reconstruction will produce a structure that approaches a new brick pavement in appearance and characteristics.

If complete statistics on the quantity of salvaging and relaying included in the work relief programs of 1933-34-35 were available, they would constitute a remarkable recital of how old brick pavements can be rehabilitated. The following data give some idea of what occurred.

In Ohio, in 1933 alone, there were 144 brick relaying projects involving work in 42 counties and creating employment for 19,000 men with a total wage of approximately $3,000,000; 1,200,000 sq. yd. of brick pavement were relaid and the average salvage was over 80 per cent. In Toledo 50 streets, including 300,000 sq. yd., were relaid and the average salvage was 92 per cent.

In the Pittsburgh district, it is estimated, approximately 300,000 to 350,000 sq. yd. of old pavements were relaid under the CWA program, the salvage value being 75 to 80 per cent.

In the city of Chicago, 16 gangs of men are at this

Brick Resurfacing Over Concrete on Route U. S. 31 Between Greenwood and Franklin, Ind., an 8¼-Mile Project Completed in 1935.

time (Dec. 1935) employed on paving brick salvaging and relaying projects in the current WPA program.

Brick pavements over 40 years old were "turned over" in Marion, Ind.; Montgomery, Ala.; Washington, Pa.; Toledo, Lancaster and Defiance, Ohio.

As the removing and cleaning of the old brick before relaying is entirely a labor item, the cost will vary with the wages paid. The cost of cleaning is also dependent upon the type of filler used in the original construction. The extreme conditions would be represented by sand filler and a rich cement grout filler. Because of the factors mentioned, the cost among different projects has varied from $1 to $12 per thousand of brick.

Mr. F. E. Hall, City Engineer of Greenville, Miss., reports that the cost of completing a reclaimed 32-year old brick pavement project this year was 50.6 ct. per square yard, using 20 ct. per hour labor.

In most of the old brick pavements the bricks were laid on edge. When relaid they are frequently laid flatwise, according to present-day practice, and there is a gain in surface area. This fact affects the percentage of salvage measured by the area covered by the relaid brick. In some cases this has actually resulted in a salvage greater than 100 per cent and a surplus of brick which were used for additional paving. Owing to the increase in manufacturing costs since the brick pavements were originally constructed 20 to 30 years ago, the relay value of the brick is in many cases materially greater than the original cost.

In the current WPA program reclaiming and relaying old paving brick are provided ideal useful relief work and incidentally exemplify the salvage value of this type of pavement.

Resurfacing

An old brick pavement can be made to serve as a foundation for a new brick or other type of surfacing. At times such practice has resulted in only temporary

satisfaction, followed by high maintenance. Some engineers prefer to take advantage of the stabilized character of the existing brick pavement—25 years or more old—as the foundation for a new brick surface. A large amount of brick resurfacing over old brick pavements has been constructed in Springfield, Ill. Mr. Morgan P. O'Brien, City Engineer, makes the statement that:

"As a plain matter of fact, easily capable of proof, an old brick pavement with either brick, macadam or low tensile strength concrete base, when it is used as a base course under a new surface, will provide a pavement that will require only a fraction of the maintenance cost of an entirely new pavement using a rich concrete base.

"The troubles inherent in a high tensile strength concrete base, advocated so strongly by many whose advice it regarded as authentic by most public officials, are non-existent in a resurfacing project. I refer, of course, to the constant expansion and contraction, with consequent cracking and blow-ups, which result in displacement and destruction of wearing surfaces of any character, to say nothing of appearance and maintenance costs. For these reasons, I have no hesitancy whatever in making the statement that the life of a pavement properly resurfaced with brick is much greater than a new pavement built with a high tensile strength concrete base, and that the cost over a period of twenty years is seldom more than half the cost of the new pavement."

He also estimates that the resurfaced streets, constructed at half the cost of a pavement with a new base, saved the citizens of Springfield during the past 5 years, $151,600.

Service Study

At the annual meeting of the Highway Research Board held in Washington, D. C., in December 1934, Anson Marston, Senior Dean of Engineering at Iowa State College, a well known engineering and highway authority, presented a most interesting report on "A Mortality Curve Study of the Actual Service Lives of Brick-on-Concrete Pavements, Des Moines, Iowa, 1909-1928." In his investigation, Dean Marston makes a unique but logical use of mortality curves, used in actuarial work, to estimate the service lives of brick-on-concrete pavements based on a construction period of 20 years.

The factual data show that, in Des Moines, 91 per cent of brick pavements 16½ years old are still in service and that 60 per cent of those 33½ years in age have survived. The statement is made that, based on the retirements of brick-on-concrete pavements in Des Moines from 1919 to 1928 inclusive (10-year period), the average life would be 36 years. Based on those retired in a 20-year period from 1909 to 1928 inclusive, the average life indicated is 28 years. In view of the improvements in brick pavement design and construction methods since 1928 it is logical to expect an average (not maximum) life of much longer than 36 years for the modern brick pavement.

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How to Remove Road Oil From Your Car.—The Minnesota state highway department gives the following directions for removing bituminous material from automobiles which have been spattered while going over freshly treated roads:

"Apply a mixture of one part lubricating oil to four parts of gasoline. Allow this to remain on the spattered surface about five minutes, then wash off with soap and water. This should be done before the bitumen has hardened.

Stabilization of Old Gravel Roads in Michigan With Calcium Chloride

Average costs of stabilizing a considerable mileage of 20 ft. gravel road with calcium chloride in Central Michigan in 1933 and 1934 are reported in the accompanying table. Most of the old gravel was quite sandy, had been in place for several years, and was well compacted. Road-mix, or mixed-in-place, methods were used.

One hundred sixty-eight cubic yards of natural binder soil (clay) and 8 tons of calcium chloride were used per mile of surface mat 3 in. thick. The cost of new gravel, stone, and slag is not included.

The costs on roads freshly resurfaced with gravel were about the same as on the old surfaces, except that in most such cases scarifying was unnecessary.

Item		Cost per mile of 20 ft. road
Binder-Soil in Pit:		
168 cu. yds. at 10c		$ 16.80
Loading Binder-Soil:		
Power shovel at $2.00 an hour for 7 hours or 8.3c per cu. yd		14.00
Hand loading:		
Team and driver 5.5 cu. yds	$ 9.24	
Men—24c cu. yd	35.28	
Hauling Binder-Soil:		
Dump trucks, 2 cu. yd. capacity, at 7c cu. yd.-mile. Average haul of 6 miles—42c per cu. yd		70.56
Spreading Binder-Soil:		
Motor grader—2 hours at $1.69 an hour or 1.9c per cu. yd		3.38
Pulverizing Binder-Soil:		
Grader at $1.69 per hour for 2½ hours		4.23
Tractor at $1.10 per hour for 6 hours		6.60
Roller at 20c per hour for 6 hours		1.20
Harrow at 20c per hour for 6 hours		1.20
Scarifying (Omitted on resurfacing jobs):		
Mechanical rake—7 hours at 80c an hour		5.60
20-ton tractor—7 hours at 90c an hour		6.30
35-ton tractor—2½ hours at $1.25 an hour		3.13
Mixing:		
Motor grader—10 hours at $1.69		16.90
20-ton tractor—11 hours at 89c an hour		8.90
Grader—11 hours at $1.04 an hour		11.44
Sprinkling:		
Tank-truck and driver—6 hours at $4.46 an hour		26.76
Shaping:		
Blade-truck—8 hours at $1.38 an hour		11.04
Calcium Chloride:		
8 tons at $19.50 (delivered price, Michigan)		156.00
Spreading Chloride:		
1 truck at 76c an hour for 2 hours		1.52
1 truck at 76c an hour for 1 hour		.76
1 calcium chloride spreader—2 hours at 10c		.20
Truck drivers—3 hours at 50c		1.50
2 helpers—3 hours at 30c an hour		1.80
Miscellaneous:		
Mixing equipment	$ 3.23	
Gas and oil	17.50	
Torch and sign labor	4.05	
		24.78
Total per mile		$394.60

▼

Seasonal Variations in Traffic in California.—Seasonal variation of traffic in the larger cities is slight. Last year, July traffic on the main city streets exceeded that of January by only 1 per cent. Traffic on rural roads, on the other hand, shows a pronounced variation during the year, and this variation is more marked on county roads than on rural state highways.

July traffic on the latter exceeded the January traffic by 50 per cent, while on the county roads, the increase was approximately 136 per cent.—*From "California Highways and Public Works."*

THE ORIGIN AND COMPOSITION OF CLAYS

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MOST all of state highway specifications for concrete aggregates include clay, either directly or indirectly, as a deleterious substance. For example, West Virginia limits the percentage of clay lumps to 1.0 per cent in fine aggregate and to 0.25 per cent in coarse aggregate. Iowa limits silt and clay to 1.5 per cent and clay lumps to 0.5 per cent in coarse aggregate for concrete. Clay in other types of road building materials is also more or less restricted in amount. The Georgia specifications for the construction of chert base and surface courses limit the clay content in the "binder" (material below the number 10-mesh sieve) to 15 to 50 per cent by weight.

In view of the various limitations placed upon clay, it was thought that a discussion of its geological aspects would be of interest to the highway engineer. This paper, accordingly, will treat with the origin and composition, as well as the classification of the various types of clay common to the United States.

Definition of Clay.—Eckle[1] defines clay as applied to fine-grained unconsolidated natural materials which possess the property of plasticity when wet, while they lose this property and harden on being strongly heated.

Ries[2] holds that clay is the term applied to those earthy materials occurring in nature whose most prominent property is that of plasticity when wet, on which account they can be molded into almost any desired shape. This shape is retained when dry, and the clay becomes hard and rocklike when heated to redness or higher. Mineralogically clay is made up of a variety of mineral fragments, ranging from fresh to decomposed ones, and in size from sand grains to particles under 1 mu in diameter.

Origin of Clays.[3]—Clays have been formed by the disintegration of rocks at the surface of the earth. When a rock is exposed to atmospheric agencies such as rain water, etc., it undergoes partial decomposition and becomes gradually disintegrated. Some of its substance is dissolved by percolating waters, themselves of atmospheric origin, and is so carried away; the remaining material, partly hydrated and partly unchanged in composition, contains products which are easily separable from one another. By flowing streams the finer clays and/or silts are taken away from the coarser and heavier sand particles.

[1]Building Stones and Clays, E. C. Eckle, John Wiley and Sons, New York, 1912.

[2]Clays, Their Occurrence, Properties, and Uses, H. Ries, John Wiley and Sons, New York, 1927.

Fig. 1

Fig. 2

The effect of rain water upon a rock is divided into several phases. First, it partially dissolves the more soluble minerals, with liberation of colloidal silica, and the formation of carbonates containing lime, iron, magnesia and the alkalies. The second phase consists in the hydration of the undissolved residue. The feldspars are transformed into kaolin, the magnesian minerals into talc or serpentine, the iron becomes essentially limonite, and the quartz grains are but little changed.

By solution, oxidation, and hydration, a solid rock is converted into an aggregate of loose material, which may remain in place as soil, or may be removed by the mechanical force of running water. In general terms, the streams separate the disintegrated materials into the coarse and finer particles. The clay-like particles are usually light and finely divided, and consequently remain longer in suspension. The heavier fragments such as sand and gravel are not carried far and thus the separation is effected. The products of the decay of rock are usually divided into two major classes, the residual and the transported. The residual products are those which remain in place such as the residual clays, while the transported materials are represented by glacial drift, loess, river clays, etc.

Classification of Clays.—There are a number of classifications of clays based upon chemical composition, uses, physical properties, etc. Below are given two working classifications based essentially on the origin of clay.

ECKLE'S CLASSIFICATION[4]

A. Residual clays.
   1. From the decay of igneous rocks.
   2. From the decay of shales or slates.
   3. From the decay of more or less clayey limestone.

B. Transported clays.
   1. Water-borne clays: transportation effected by water.
      (a) Marine clays; deposited in salt water basins.
         1. Marine clays proper.
         2. Shales.

[3]The majority of this subject matter is based on "Data of Geochemistry" by F. W. Clarke, U. S. G. S. Bulletin 770.

[4]Op. cit.

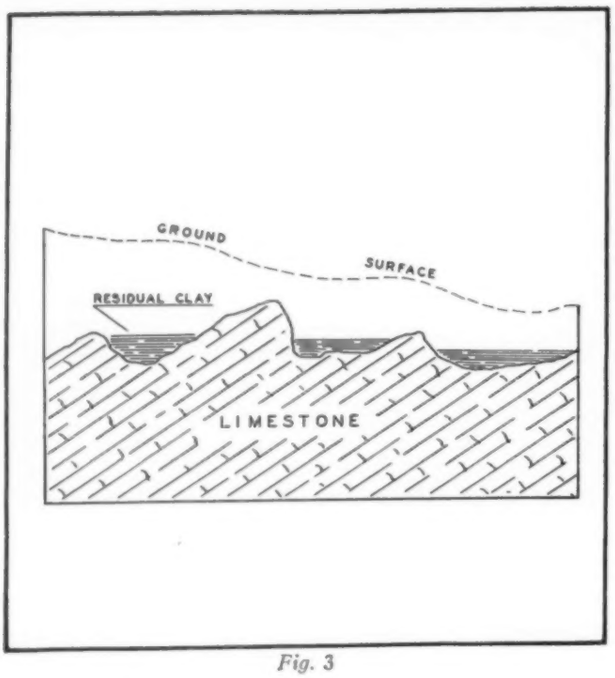

Fig. 3

3. Slates.

(b) Stream clays, deposited along the courses of streams or rivers.

(c) Lake clays, deposited in lakes or ponds.

2. Ice-borne or glacial clays: transportation effected by glacial ice.

3. Wind-borne or eolian clays: transportation effected by the wind.

CRIDER'S CLASSIFICATION[5]

I. Residual clay.
- A. Clays derived from igneous rocks.
  - a. Kaolin derived from granite and other feldspathic rocks.
  - b. Ferruginous and impure kaolin derived ordinarily from igneous rocks containing hornblende and other ferro-magnesian minerals.
- B. Clays derived from metamorphic rock.
  - a. Kaolin derived from gneiss and from other feldspathic metamorphic rocks.
  - b. Impure kaolin or clay derived from slate, schist or argillaceous marbles.
- C. Clay derived from sedimentary rocks.
  - a. Surface clay derived from shale.
  - b. Surface clay derived from argillaceous limestone.
  - c. Surface clay derived from argillaceous sandstone.

II. Transported clays.
- A. Fluvatile clays, those transported by streams.
  - a. Delta clays, those deposited in deltas.
  - b. Estuary clays, those deposited in the broad mouths of rivers.
  - c. Flood-plain clays, those deposited on the flood plains of rivers.
- B. Lacustrine clays, transported and deposited in lakes.
- C. Marine clays, transported and deposited in marine waters.
  - a. Unconsolidated beds of clays.
  - b. Shales, compact laminated clays.
- D. Glacial clays, those transported by ice.
  - a. Till.
  - b. Loess (in part).
- E. Eolian clays, transported by winds.
  - a. Loess (in part).
  - b. Adobe clays.

[5]Cement and Portland Cement Materials of Mississippi, by A. F. Crider, Bulletin No. 1, Miss. Geol. Survey, 1907.

Residual clays owe their derivation to the decay or disintegration of existing rock, by the action of natural agencies. For example, igneous rocks such as granite contain feldspar, quartz, muscovite or biotite mica and probably some ferro-magnesian minerals such as hornblende or pyroxene. Under the action of the weathering agencies the feldspars break down with relative ease, the micas and the hornblendes decay less rapidly than the feldspars, while the quartz is unaffected. From this decay of the feldspars and the micas come the residual deposits of clay. The following equation shows the reaction of the orthoclase feldspar when attacked by rain water containing carbon dioxide:

Ortho-clase		Water		Carbon Dioxide		Clay		Quartz		Potassium Carbonate
$2KAlSi_3O_8$	+	$2H_2O$	+	CO_2	=	$H_4Al_2Si_2O_9$	+	$4SiO_2$	+	K_2CO_3

In the decay of the more basic rocks such as trap, gabbro, etc., the residual clays are generally more impure than those derived from such acid rocks as granite and other similar types. This is due to the low silica and relatively high iron, lime, and magnesia content. Regarding the formation of residual clays from limestones, Eckle[6] states that

> Limestones are composed essentially of lime carbonate, or a mixture of lime and magnesium carbonates. Some contain little else than these carbonates, but by far the majority of limestones carry appreciable percentages of clayey matter (silica, alumina, and iron) and often other impurities (sulphur, alkalies, etc.). Most of these impurities—and particularly the clayey materials—are very insoluble, as compared to lime and magnesium carbonates. The latter are readily attacked by water carrying dissolved carbon dioxide. When bed of limestone is permeated by waters so charged, the carbonates of lime and magnesia are carried off

TABLE I—ANALYSES OF THE VARIOUS TYPES OF CLAY

	Residual Clay (A)	Marine Clay (B)	Stream Clay (C)	Loess Clay (D)
Silica	55.42	62.80	52.73	74.39
Alumina	22.17	18.23	22.25	12.03
Iron oxides	8.30	6.40	7.69	4.06
Lime	0.15	0.88	1.48	1.50
Magnesia	1.45	1.58	3.20	1.53
Alkalies	2.49	3.05	6.50	3.01
Carbon dioxide	....	....	4.91	....
Water	9.86	1.31		3.17

(Data from "Building Stones and Clays," by E. C. Eckle.)
(A) Material from Morrisville, Ala.
(B) Material from Thomaston, Me.
(C) Material from South Windsor, Conn.
(D) Material from Jefferson City, Mo.

TABLE II—ANALYSES OF VARIOUS ROCKS AND THEIR DECOMPOSITION PRODUCTS

	Micaceous Gneiss		——Diorite——		——Diabase——	
Oxides	Fresh Rock	Residual Soil	Fresh Rock	Decomposed Rock	Fresh Rock	Decomposed Rock
SiO_2	60.69	45.31	46.75	42.44	43.56	44.93
Al_2O_3	16.89	26.55	17.61	25.51	14.58	16.27
Fe_2O_3	9.06	12.18	16.79	19.20	3.84	13.37
FeO					7.00	....
MgO	1.06	0.40	5.12	0.21	9.95	6.40
CaO	4.44	Trace	9.46	0.37	10.78	1.84
Na_2O	2.82	0.22	2.56	0.56	1.86	2.03
K_2O	4.25	1.10	0.55	0.49	1.02	0.84

(Analyses from "Data of Geochemistry," by F. W. Clarke, U. S. Geological Survey Bulletin 770, 1924. Only essential constituents given.)

[6]Op. cit.

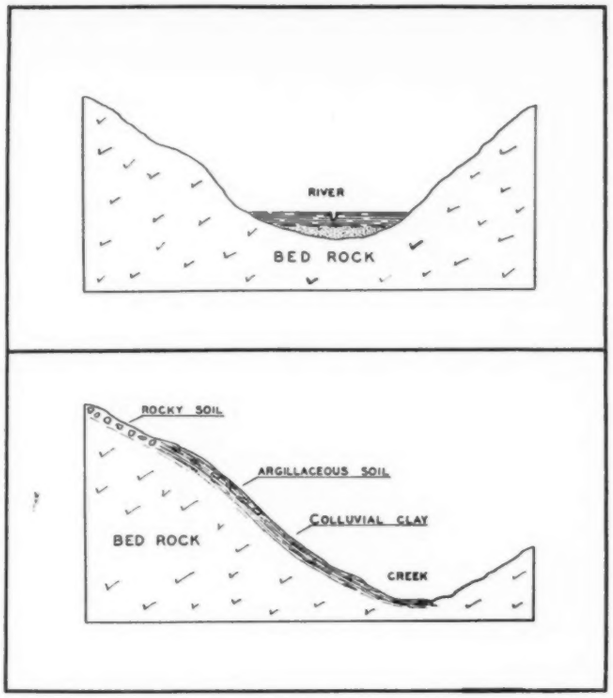

Fig. 4

in solution, while any clayey matter which may have been contained in the limestone is left behind. Long exposure to such action will result in the removal of a vast amount of limestone, and in the accumulation of a great thickness of residual material (clay, chert, etc.) as a mantle over the remnant of the limestone, even when the original limestone contained very small amounts (1 to 3 per cent) of such clayey matter.

As a general rule residual clays are more or less impure and unstratified, and are usually brightly colored due to the complete oxidation of the iron. The varieties of clay called "laterite" and "bauxite," belong to this type of clay.

Transported clays differ from residual clays in that the material has been moved from its original place of deposition to another point more or less distant. The transporting agency may be either running water, glacial ice, or wind although it is quite probable that water is the most common transporting medium.

Marine clays, as the name denotes, refers to those clays which have been formed and are now forming, on the ocean floors. However, some marine clays formed in the geologic past, have been elevated by regional movements and are now exposed at the earth's surface. But due to long exposure, and to continued pressure, they have become hardened into shales or slates.

Stream clays are those found in terraces along the banks of rivers or in the stream bottoms. Rainwater washes the decayed rock into gullies, thence to small streams and eventually into larger streams. Due to their density, the larger particles are deposited first near the stream heads, while the finer particles are carried down stream in suspension. During flood periods the velocity of the stream is diminished with the result that the clay and fine silt are deposited. This accumulation continues until thick beds are gradually built up.

Glacial clays are found in that portion of the United States covered by the ice sheet. This variety of clay is composed essentially of the materials over which the glaciers moved, and usually is heterogeneous in composition. These clays quite often contained fragments of rocks, sand, etc. Some deposits of glacial clays have been sorted and formed by the action of water and these deposits are, of course, merely the same material with the exception that they have undergone sorting to a limited extent.

In the central part of the United States, there are certain deposits of clay-like material which have been wind-borne. These clays are called loess. In these cases the sorting and transporting was accomplished by the wind.

Chemical Composition of Clays.—The minerals commonly found in clays may be listed as follows: kaolinite, quartz, plagioclase feldspar, orthoclase feldspar, biotite mica, muscovite mica, limonite, hematite, magnetite, hornblende, pyroxene, pyrite, calcite, gypsum, rutile, and tourmaline. There are numerous other minerals but those listed above may be considered as the essential ones.

Kaolinite, which is a hydrated silicate of alumina of the formula $H_4Al_2Si_2O_9$, is usually regarded as the base of clays. Shand[7] is of the opinion that kaolinite is sometimes considered as the typical clay-silicate. The essential condition for the formation of kaolinite from feldspar is a high concentration of carbonic acid in the attacking solution. Halloysite, allophane, montmorillonite, etc., are clay-like substances which show certain differences in optical character and resistance to acids, and are therefore regarded as distinct species in spite of the difficulty of establishing their purity. Kaolinite is usually white in color and has a specific gravity rang- from 2.2 to 2.6. It is also a very stable compound, and as stated before is the chief residual product of feldspathic decay.

Quartz is considered the most common mineral impurity in clays and varies greatly in the amounts present in different clays. This is logical since quartz in some form or another is present in practically all rocks of the earth's crust, and in addition is almost entirely unaffected by atmospheric agencies. However, the quartz particles may be colorless or stained by iron oxides, but in any event they can rarely be seen with the unaided eye.

Feldspars are almost as abundant as quartz in clays, but due to the rapid decomposition the particles are hardly ever as large. The chief varieties of feldspar include plagioclase, orthoclase, albite, oligoclase, and anorthite, with the plagioclase being somewhat less resistant to weathering than the orthoclase.

Mica is found in almost all igneous and sedimentary rocks, therefore is found also in the clays. Its thin scaly, shining surface can easily be detected, even when small in size. Muscovite mica usually retains its light color, while the biotite mica is almost always changed from its original black appearance due to the leaching

[7]The Study of Rocks, S. J. Shand, Thomas Murby & Co., London, 1931.

Fig. 5

out of the iron compounds. Almost all clays contain mica in more or less amounts, and some clays are highly micaceous.

The ferro-magnesian minerals such as hematite, pyrite, magnetite, siderite, etc., are found in most clays. The hematite and magnetite change to the limonite form upon exposure to the air. Siderite, which is a carbonate of iron, may be present in such quantities as to produce a clay having a decided bluish or slate-gray color. Pyrite can sometimes be detected with the unaided eye, and when exposed to weathering changes to limonite after passing through the iron sulphate stage.

Grain Size Clays.—Classification of the finer sizes of such sedimentary material as clays and shales according to grain size is also worthy of discussion. For example Grabau[8] gives the following tables as the standard sizes of rock fragments. (Only the finer grain sizes are here given.)

Very coarse sand	2.500 to 1.0000 mm.
Coarse sand	1.000 to 0.5000 mm.
Medium sand	0.500 to 0.2500 mm.
Fine sand	0.250 to 0.1000 mm.
Rock flour	0.050 to 0.0100 mm.
Superfine flour	0.010 to 0.0050 mm.
Clay size	0.005 to 0.0001 mm.

Tyler[9] states that the material separated from a clay deposit may be classified according to size as follows:

Coarse sand—Over 0.33 mm.

Fine sand—Grains 0.04 to 0.33 mm.

Dust sand—Grains 0.025 to 0.04 mm. and suspended in a stream of 1.5 mm. per second.

Silt—Grains 0.01 to 0.025 mm. and not settling in a current of 0.7 mm. per second.

Clay—All grains under 0.01 mm. and not settling in a current of water with a velocity of 0.18 mm. per second (20 mm. head).

There are numerous methods for determining the grain size of clay, such as the "settling method," the "elutriation method," the "whirlpool classifier," the "air elutriator," the "centrifugal separator," and the "hydrometer method."[10] Most investigators seem to agree that the clay size ranges between 0.005 and 0.0001 mm.

BIBLIOGRAPHY

1. Rocks, Rock-Weathering and Soils, G. P. Merrill, The Macmillan Co., New York, 1897.
2. Clays of Mississippi, W. N. Logan, Bulletin 2, Mississippi Geological Survey, 1905.
3. Clays and Shales of Minnesota, F. F. Grout, Bulletin 678, U. S. Geological Survey, 1919.
4. Microscopic Examination of Clays, R. E. Sommers, Washington Academy of Science Journal, vol. 9, 1919.
5. A Preliminary Report on the Clays of Florida, O. G. Bell, 15th Annual Report, Florida State Geological Survey, 1924.
6. Clays and Shales of Michigan and Their Uses, G. G. Brown, Michigan Geological and Biological Survey, Publication 36, 1926.
7. The Minerals of Bentonite and Related Clays, and Their Physical Properties, C. S. Ross and E. V. Shannon, Journal American Ceramic Society, vol. 9, 1926.
8. The Chemistry and Physics of Clays and Other Ceramic Materials, A. B. Searle, Ernest Benn, Ltd., London, 1924.
9. Uses of Clay in Roadmaking, A. B. Searle, Roads and Road Construction, vol. 2, No. 23, 1924.
10. Clay Soils in Relation to Road Subgrades, H. H. Bennett, Public Roads, vol. 6, No. 8, 1925.
11. Road Building Upon Clay, W. W. Davies, Surveyor, vol. 76, No. 1970, 1929.
12. Colloidal Nature and Water Content of Clays, H. Berridge, Engineering, vol. 130, No. 3364, 1930.
13. Physical and Mechanical Properties of Clay, H. Berridge, Engineer, vol. 132, No. 3420, 1931.
14. Cohesion and Viscosity of Clays, E. G. Richardson, Journal of Agricultural Science, vol. 23, Part 2, April, 1933.
15. Colloidal Nature and Related Properties of Clays, W. W. Meyer, Research Paper 706, National Bureau of Standards, Washington, D. C.
16. The Separation and Identification of the Mineral Constituents of Colloidal Clays, Matthews Drosdoff, Soil Science, vol. 39, No. 6, June, 1935.

[8]Principles of Stratigraphy, A. W. Grahau, A. G. Seiler & Co., New York, 1924.

[9]Clay, P. M. Tyler, Information Circular 6155, Rev. U. S. Bureau of Mines, Washington, D. C., March, 1935.

[10]For a description of these methods see "Clays, Their Occurrence, Properties, and Uses" by H. Ries, 3rd ed., John Wiley & Sons, New York, pp. 195-209.

Analysis of Highway Building Traces Effects on Employment

The far-reaching effect of highway construction is creating employment directly on the road and in many industries is shown in a publication entitled "An Economic and Statistical Analysis of Highway Construction Expenditures" issued by the Bureau of Public Roads of the U. S. Department of Agriculture.

An expenditure of $100,000,000 for highways initiates a movement, analysis shows, resulting in the transaction of business to the extent of $315,000,000 and causing the employment of 103,000 men for one year.

Highway construction may be managed to provide employment in rural and urban areas approximately in proportion to unemployment in the respective areas, says the Bureau. The variety of highway types and degrees of mechanization makes possible considerable adjustment to meet employment needs. Although highway construction has the conspicuous advantage of flexibility in creating employment where there is the greatest need, it also produces substantial employment in many industries.

An expenditure of $100,000,000 for highways is analyzed. The expenditure is assumed to be made for highways of the types, in the locations, and under the conditions of expenditures in recent years. The direct employment on the road is shown and also the first distribution of funds to various industries. These expenditures generate still other expenditures through the purchase of materials, equipment and supplies. The report traces, step by step, the industrial activity and employment in 23 basic industries involved in handling and processing highway materials and supplies. These materials and supplies originate in quarries, mines, forests, and fields and pass through many hands before they are finally used to form a finished highway.

Copies of the report are available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., for 15 cents each.

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Kettle Fires

When an asphalt heating kettle catches on fire it is usually due to (1) Overheating; (2) Moisture in the tar or asphalt; (3) Material low in melting tank without reducing the heat; (4) Poor oil hose.

The first of these causes can be eliminated by using a thermometer. The second is not entirely avoidable. The third may be due to a new operator, but is hardly excusable because the dark color of the vapor coming off the material in the kettle before it flashes is usually a signal for shutting down the burner. The fourth cause can be remedied by using a suitable oil-resisting hose.

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Finnish Town Originated Silent Traffic

The small town of Turku in Finland claims credit for beginning the plan of silent motor traffic, the idea of which has now spread to Rome, London, Stockholm and other centres. It began, so Turku claims, with the disturbance by motor horns of a conversation between the Turku chief of police and a friend. The friend became angry at the honking, and the chief of police promised to do something about it. The next day all chauffeurs were informed that all uncalled-for blowing of horns was forbidden. Other towns and cities in Finland followed suit.—*New York Times.*

SAFETY FEATURES MAIN CONSIDERATIONS

In Improvement of Albany-Schenectady Road in Albany County

THE old road between Albany and Schenectady, N. Y., consisted of two 9-ft. lanes of concrete separated by a 6-ft. strip of macadam. A traffic count in August, 1934, showed the average week day traffic on this route was 7,471 passenger vehicles and 1,419 trucks.

Fronting the 7½ miles recently improved are 4 schools. Fourteen hundred children attend these schools, and twice a day, or oftener, 600 of these children cross the highway. Here was a condition that called for more than careful driving. For traffic would be completely blocked if each motorist exercised the care necessary to avoid possibility of an accident.

The accident record is evidence of this. In the 18 months immediately preceding the improvement there were 36 reported accidents on the old highway with 8 deaths and 15 injured persons.

When engineers prepared plans for widening this road, safety of motorists and school children was a major consideration. The two major provisions for safe construction were (1) to separate streams of traffic in opposite directions with an earth parkway, and (2) to build underpasses at each school. The original alignment and grade was good, so few changes were made. The concrete slab of the old surface was in good condition.

The new pavement is 39,994 ft. long, 22 ft. wide, and of 8 in. uniform thickness, built in 11 ft. lanes with expansion joints at 90 ft. intervals. It is separated from the old pavement by a 12 ft. parkway, thus separating traffic flow in opposite directions. The new slab was placed on the old bed of the Schenectady interurban line which consisted of a practically uniform 8-in. ballasted subgrade. Where conditions required, concrete pipe were installed for drainage.

One of the Crossovers Constructed to Connect the Two Sides of Double Highway at an Intersection

Cement, Gravel and Sand Batching Plant

General View of Placing Concrete

Joint construction is unique. A premolded joint was used with the top ¾ in. below the surface of the pavement. This was covered by a cap. After machine and hand finishing, the cap was raised to the surface. The pavement was then broomed, the cap removed and the joint finished. The depression over the joint material was then filled with bitumen. Four test joints were also filled with a fluid rubber compound.

This method of joint installation was tried to eliminate bumps caused by interference of joint material with the finishing machine. Results were considered satisfactory. The uniform, gritty, true and even surface of the concrete thus obtained adds further to the safety of the improvement.

The pavement was cured with cotton mats, which were sprinkled at intervals.

The underpasses are 89 ft. long, 5 ft. wide (inside), and 6 ft. 10¾ in. high (inside). Walls are 10 in. thick; floors, 11½ in. thick; and roof, 9 in. thick, all reinforced. While the kiosk is striking in appearance, this result was achieved by utilizing concrete as an architectural medium but without resort to elaborate ornamentation.

Construction View of Pedestrian Underpass in Front of Roosevelt School Showing Inner Forms in Place in Tunnel Wall

Sufficient time has not elapsed to report the influence of this improvement on the accident rate on the road.

The contractor is the Madison County Construction Co. Laborers on the job were taken from the rolls of the National Reemployment Service, U. S. Department of Labor, New York State. As the job was approximately 90 per cent in Albany County and 10 per cent in Schenectady County, the labor was hired from those counties in that ratio.

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Montana Road Builders Watch for Relics

In a memorandum addressed to "All Highway Department Employees and Highway Contractors," D. A. McKinnon, State Highway Engineer of Montana, on Nov. 23, 1935, gave positive instructions for the preservation of all geological and archeological remains which may be discovered in the course of highway construction. The memorandum cites important finds in other states, and contains the following relative to Montana:

"The opening of new highway cuts and gravel pits in Montana promises possible scientific discoveries of great value both to geology and to archeology. The geologist may study from the complex sands and gravels the history of glaciation and of post-glacial stream action, as well as the climatic changes which led to the formation of present soils. Intimately bound up with these cycles is the history of man in North America. Archeologists are looking more and more to the northern Plains for discoveries of early human occupation."

"The following instructions are for your guidance:

"(1) In your excavations watch for all indications of prehistoric life. These indications will include fossilized bones, weapons, tools, implements, ashes, blackened stones and other signs of fire.

"(2) When you make such a find, *stop digging immediately around the objects.* Take the greatest care not to move or disturb them. The original position and arragement may prove to be the means of determining the time and living conditions of those who left these signs of their life.

"It is suggested that if such a discovery is made highway engineers and contractors report immediately to Montana School of Mines, Butte, by telegram or by letter, stating the place and general character of the objects discovered. If the discovery promises to be of importance, the nearest competent geologist or archeologist will be directed to visit the excavation at once, remove the objects, and care for them. The name of the discoverer will be mentioned in all later records of the objects or bones.

"Your strict compliance with the above is expected."

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STATE HIGHWAY OFFICIALS TO MEET IN FEBRUARY.—The 12th annual convention of the Association of State Highway Officials of North Atlantic States will be held Feb. 12-14 at the Hotel Ambassador, Atlantic City, N. J. A. Lee Grover, Secretary New Jersey State Highway Commission, Trenton, N. J., is Secretary-Treasurer of the Association.

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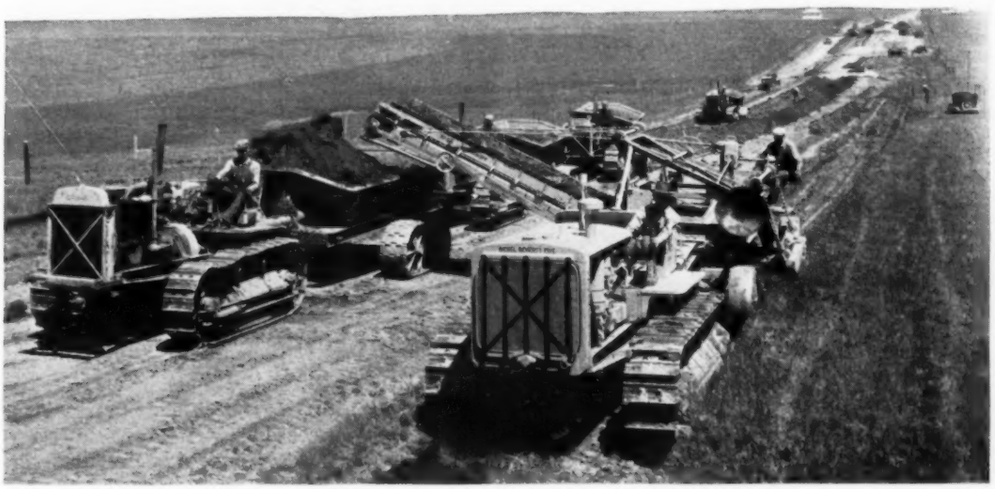
SOUTHWESTERN ROAD SHOW TO BE HELD IN FEBRUARY.—The 9th annual Road Show and School and the 33rd annual Power Farm and Equipment Show will be held in Wichita, Kan., at the Forum on Feb. 25, 26, 27, 28, 1936.

INTERNAL-COMBUSTION-ENGINE POWER in the HIGHWAY INDUSTRY

By GORDON C. OLSON

Formerly Editor of MOTIVE POWER



A typical scene in highway construction showing engine-powered elevating graders and crawler dump wagons being operated by Diesel and gasoline tractors

PART I---The Early Highway Industry and Steam Power

PART II---The Heavy-Duty Gasoline Engine

PART III---The Air-Cooled Industrial Engine

PART IV---The High-Speed Diesel---and Other Oil Engines

Power has come to be a most important factor in all highway construction and maintenance operations. No engine-powered machine can be designed without taking into consideration the source of power, while the engine designer usually incorporates into his design as near as possible those power features that are required. The power and equipment manufacturers are interrelated and both must view the power problem—but from different angles. The operator cannot be indifferent as he is conscious of the degree of success attained in the final machine. There has evolved in the highway industry this dual development of machines and engines. It is the endeavor of the author to trace this development from the power viewpoint, outlining some of the problems encountered and how they have been successfully solved in the design of diversified types and sizes of engines. Obviously it is impossible to adapt an article of this kind to all the classes of readers but an attempt has been made at simplicity and yet not to the omission of many important technicalities. The author and publishers join in expression of appreciation to the many individuals and manufacturers whose contributions have aided materially in the preparation of this article.

Fig. 1 — Two of the earliest gasoline tractors of the caterpillar type hauling material across the Mojave desert for the Los Angeles Aqueduct, 1908

THE EARLY HIGHWAY INDUSTRY AND STEAM POWER

THE highway industry has grown into one of the greatest enterprises of our nation. As one looks back over man's history, he observes an increasing tendency to travel and transport goods. Man's desire for experiences and tangible objects has caused him to desire transportation. When man utilized no principal vehicle but traveled afoot and by beast natural highways were generally sought out and used, but as animal-drawn vehicles came increasingly into use an increasing demand was made for the constructed roadway. And yet the development of the vehicle and its road must have been simultaneous for they are inseparable. Man constructed the road for his vehicle, but also his vehicle for his road. Of what use would the highly-developed present-day automobile truck, or bus be without its counterpart—the well-constructed highway. On the other hand, what would be the need for our great highway system but for these vehicles.

A similar relation has existed between the type of roadway that man would like to have built and what he was able to build for raw materials and perfected compounds for road construction needed to be developed. Again, if man had the materials without the modern and efficient methods, it would be impractical if at all possible to construct the modern highway. So as man saw what was desirable in highway construction and the operations that needed to be performed, he gradually devised mechanical means to perform as many of the operations as possible. In this last statement is included the gradual evolution of methods and machinery of excavation.

But machinery and tools require man-power, animal-power, or engine-power, an engine being a mechanism for converting stored thermal or heat energy taken from the earth into mechanical energy such as can be used for the performance of work. Therefore what man can develop in the way of devices for highway construction depends upon his being able to produce a suitable motive power. It has often occurred that man has had ideas of particular machines lying dormant in his mind pending the development of suitable power to make his machine possible, while, as we shall abundantly see, man's having available a suitable source of power has caused him to devise new machines for its use. It is the power unit and its relation to the industry under discussion with which this series of articles shall be specifically concerned. It is hoped that the reader may be led to a better understanding of the power problems in highway industry and how they have been successfully met —considering available fuels and their conversion into mechanical energy by engine design. One cannot even approach a conception of all the scientific and engineering skill that has been invested in the internal-combustion engine as we know it today. However for the non-technical man in engine design, a historical review and a general discussion of present practice of such power units as are being applied in the industry under consideration should prove of inestimable value.

No attempt will be made to classify the various forms of excavators and types of operations performed as we desire to consider the machines from the power standpoint. It is common knowledge that the steam engine furnished the only source of engine power for road-construction operations for some extended period, but to a limited extent. Horse-drawn machines, receiving their rotative power when needed by traction, dominated the industry until steam power entered certain applications as portable units were made available. It has not been until comparatively modern times, however, that horses have been entirely displaced. A brief sketch of steam-engine development and its application to the power needs of our industry should be of interest.

The Elementary Idea of an Engine

We think of an engine as consisting of a cylinder with a closely-fitted, movable piston connected by means of a connecting rod to a crank arm so that the reciprocating motion of the piston will cause rotary motion of the crankshaft—the cylinder and the crankshaft being held in position by a frame. The movement of the piston, and the consequent rotation of the crank, is to be obtained by a force acting on the piston. This force will be equal to the area of the piston multiplied by the dif-

ference in pressure between the two sides of the piston. If one end of the cylinder is closed to the atmosphere and suitable arrangements made to permit the admittance of a certain gas under pressure, while the other side of the piston is exposed to atmospheric pressure, the movement of the piston or the force exerted by the piston is equal to the difference between the gas pressure and atmospheric pressure multiplied by the piston area. If this force can be harnessed, as with a connecting rod and crankshaft, it can be utilized to produce rotative motion. This is the elementary idea of any engine and there must be devised a means of producing pressure in the closed end of the cylinder (assuming a single-acting engine), expansion of the gases, and their exhaust to complete the cycle.

Since the heating of a gas in a closed vessel produces pressure, our starting point must be with some fuel or combustible substance that liberates a large quantity of heat units upon ignition. Our aim must be the getting of some gas or working medium into the cylinder under pressure. Here a broad classification of engine types as external-combustion engines and internal-combustion engines might be made—depending on whether the fuel containing the heat units is burned outside the cylinder and the heat communicated to some medium in a closed chamber which at proper intervals is led into the cylinder in its heated condition to act upon the piston; or whether the fuel itself is led directly into the cylinder and there ignited, with the gases that form the products of combustion themselves being heated and increased in pressure and acting upon the piston. It is in the former class that the steam engine falls; while the latter class manifestly includes the gas, gasoline, Diesel, and other oil engines. As the title expresses, it is with the latter classification that this series of articles will attempt to deal.

The Steam Engine and Its Industrial Applications

Before entering upon our discussion proper, the steam engine and its entry into our industry should be outlined. An elementary steam power plant has three essential elements: the furnace, the boiler, and the engine. Fuel of some sort is fed into the furnace, where it is burnt; causing a portion of the heat liberated to be absorbed by the water in the boiler, evaporating it into steam under pressure; which steam is conducted to the engine cylinder, doing work on the piston and consequent turning of the crankshaft, and then exhausted to the atmosphere at the end of the piston stroke. It might be called an external-combustion engine because the fuel is burned outside the engine cylinder. A number of accessories are necessary to the operation of such a plant which need not be gone into here. The amount of steam evaporated must correspond to the amount consumed by the engine and is regulated by controlling the amount of fuel burned in the furnace by suitable means. There have been numerous refinements in steam power plant engineering but the plants generally found in small portable and semi-portable machinery have been of this elementary form.

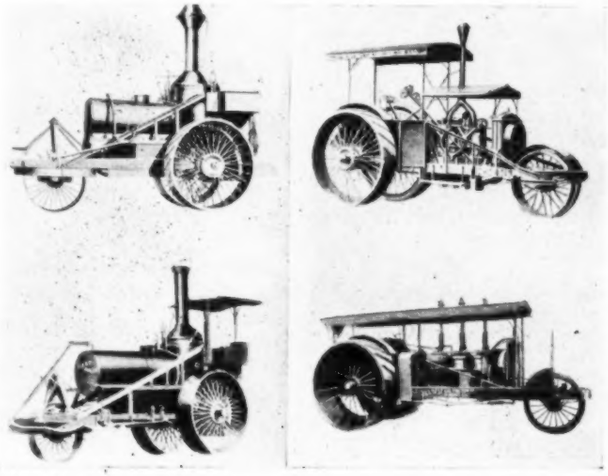


Fig. 2—Composite picture of early steam and gasoline tractors. The steam units are dated 1897 *and* 1900, *upper and lower left, respectively; while the upper right shows Best's first gasoline tractor,* 1909, *and the* "80," *a 6-cylinder gasoline tractor,* 1912, *lower right*

Man's knowledge of the expansive force of water vapor appears from history to extend back 2000 years or more, and while there were earlier steam engines, James Watt's engine was patented in 1769 which consisted of definite improvements over existing engines, numbering seven claims. He later patented other features. The progress of the steam engine from that time onward consisted in better construction, increased steam pressures, adding to the number of cylinders, and general refinement for application to the type of equipment under consideration. The stationary power plant has attained a high degree of perfection as far as steam equipment goes.

It is said that the first road locomotive, as it was called, was produced in England during the early part of the last century. It was the forerunner of the present day railroad locomotive. A long period intervened until the successful early traction engine was developed. Doubtless we must look to agriculture for the major tractor development or the occasion of the development. There appears to have been two major divisions of endeavor divided according to the size and type of farms to which the tractor was to be applied. Two different types of machines, differing as to size and principle, resulted. On the west coast in the area of large scale farming, agricultural implements of a very large type were in use, necessitating large teams of horses of 30 or more in one unit. The difficulty encountered in managing such a team and the demand for tractor power that would operate successfully on the hot, dry, and dusty fields gave rise to inventive genius during the latter part of the last century.

But while the occasion was agriculture, these steam units, such as are illustrated in Fig. 2, were used fully as much in industry for road construction work. The early units were of the wheel type and because of their tremendous weight many applications were unsuccessful —the soil conditions would not support such a unit. Wheels of extreme width were constructed but without sufficient success. In 1900 Benjamin Holt constructed a pair of tracks, or "platform wheels" as they were called, out of available parts found in his plant. This crude device indicated success and another unit was constructed but even he did not realize what the extent of development along these lines would be and conceived of his track-type tractor as merely a special purpose machine adapted for certain adverse conditions. Experience taught that on a certain plowing test one of the standard 40-hp. steam tractors mounted on caterpillar tracks could pull the load formerly drawn by their 60-hp., wheel-type steamer. In later years, after the introduction of the gasoline engine to track-type tractors (an early model of which is shown in Fig. 1), the track principle was subject to a great deal of criticism and it appeared doubtful whether it would ever be widely used. But the World War accentuated the need for such a

machine and probably did more than any other event to establish the track principle for larger tractors such as are found in the highway industry.

The first steam shovel was developed in this country about 100 years ago and was applied in railroad construction. The company that produced these units, some 1000 in number, finally passed out of existence and it was not until the early eighties when many excavation projects were under view that the steam shovel received its real development. The power shovel is a machine that performs two main operations: breaking up and handling or loading (Fig. 15). It has three elementary movements: hoisting, crowding, and swinging. The energy consumed in the three operations has been estimated as 60, 20, and 20 per cent respectively. The early shovels were of the single engine type driving these three independent movements of the machine through friction clutches. A great deal of clutch action is obviously necessary and especially on the crowd where it is required to hold a constant pressure against the digging operation. One of the most important improvements in excavators was the introduction, during the latter part of the century, of three individual steam engines all fed from the same boiler to operate independently the three functions or movements of the excavator. This became universal practice and the steam excavator became highly developed and useful. Steam power was used for many other applications in road work, such as steam rollers, locomotives, hoists, ditchers, etc., but never invaded the field as fully as the position now occupied by internal-combustion engines.

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THE HEAVY-DUTY GASOLINE ENGINE

SINCE the steam engine could utilize a wide variety of fuels, it held greater possibilities of early development than the internal-combustion type which was exacting in its fuel requirements. Not until the discovery of crude oil and the early development of petroleum refining did the internal-combustion engine become a practical possibility to compete with steam, although the burning of a combustible mixture within an engine cylinder had been considered during early steam-engine development. It is apparent that if a fuel can be successfully burned within the cylinder itself many heat losses can be avoided. Instead of the heat energy needing to be transferred from the heated products of combustion to some other medium (as in the case of the steam engine), the air and products of combustion themselves with their increased pressure act upon the piston. The furnace and the medium are within the cylinder. By the use of water jackets, the outer surface of the metal cylinder walls could be kept at low temperatures. This permitted the inner surface to be exposed to the desired extreme temperatures of combustion without destruction or deformation.

The first internal-combustion engine of any practical importance and one which proved commercially successful was the Lenoir engine patented in 1860 in France. It resembled a double-acting steam engine and did not compress the charge of fuel and air before explosion. The charge was drawn into the cylinder for about one-half of the intake stroke when the inlet valve closed and the charge ignited and permitted to expand until the end of the stroke. The return stroke was used to exhaust the cylinder. Since it was a double-acting engine, one power impulse occurred during each stroke. Compression of the charge before ignition is the important element of efficiency and thus this engine was very inefficient.

This important element in engine efficiency was developed and patented in 1862 in Paris by Beau de Rochas, a scientist, who outlined the four-stroke cycle such as employed in the gasoline engine at present. He first mentioned the operations that he thought necessary and then specified four strokes of the piston to complete the cycle. First, a charge of air and gas were to be drawn into the cylinder at atmospheric pressure. Upon the return stroke, with the valves closed, the charge was to be compressed to its highest practical pressure and

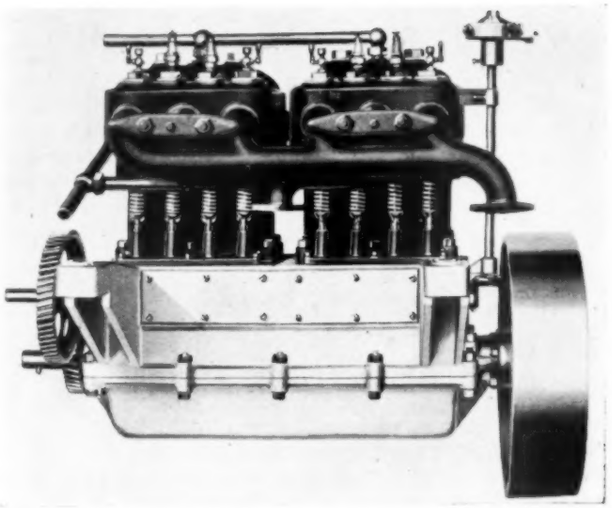


Fig. 3—One of the earliest gasoline engines for heavy-duty service produced in 1906 *by the Waukesha Motor Co.*

temperature. With the piston at the end of the compression stroke, the charge was to be ignited and burned instantly at nearly constant volume, or practically without any movement of the piston. The temperature and pressure would rise and the gases expanded to atmospheric pressure and exhausted on the return stroke, thus requiring two revolutions to complete the cycle (see Figs. 16, 17, 18, and 19). A German by name of Otto, who was of a more practical mind than Beau de Rochas, capitalized on this statement of principles and produced a practical engine which he exhibited in Paris about 1875. Because of the large number of engines produced by Otto and his licensees and the popularity of his engines, the four-stroke cycle now employed in the gasoline engine came to be known as the Otto cycle. A few years later in England an engine was brought out which performed the four strokes of the Otto cycle in two strokes of the piston. This came to be known as the two-cycle engine. About this time a crude type of carburetor was introduced which made it possible to use gasoline as fuel. All the earlier engines used gas or

benzine as fuel. This development made possible the portable engine development.

The gasoline engine of the multi-cylinder design for industrial applications is doubtless an offshoot from the early history of the automobile and had at an early stage grown into a separate industry. It was recognized that the passengar car engine, while fulfilling its design purposes excellently, was not well adapted to the heavy duty service demanded in industry which had to be considered in engine design. Gradually the industrial engine came to be used on trucks, tractors, industrial locomotives, power shovels, portable hoists, portable compressors, concrete mixers, special-type excavators, etc. An early type of the multi-cylinder industrial engine is shown in Fig. 3.

Definition of Engine Horsepower and Torque

In considering the displacement of the steam engine by the gasoline engine in road-construction machinery a brief mention of power requirements should be made. This has been so complete that in the last conquest of the internal-combustion engine, the steam-powered excavator, it has been estimated that for sizes up to 2-yd. capacity not over one per cent of the industry's present output is powered by steam. As we view the many types of road machinery and their power requirements, we are accustomed to use certain terms which are sometimes understood and sometimes not. The most common term is the word, horsepower, and then comes the word, torque. These terms among others are indicative of the qualities of an engine and are commonly represented in graphical form, as in Fig. 4, rather than in figure form. They represent what the engine will do at its various speeds of operation and are therefore called performance curves. Other factors of interest, especially the fuel economy, are recorded in a similar manner.

Horsepower—Power is the rate of doing work while work must be measured by the product of force and the distance it passes through. Work involves no time factor and if 330 lbs. be lifted through a distance of 10 ft., the work done will be a product of the two or 33,000 ft. lbs. The work done is the same whether it be done in one minute or ten. But since power is the rate of doing work, a time factor enters and if the above mentioned work be done in one minute, the power exerted is a product of the three or 33,000 ft. lbs. per minute. We might as well have rated our engines at so many thousands of ft. lbs. per min., but for the sake of convenience, a standard unit has been employed which involves ft. lbs. per min. Upon dividing the thousands of ft. lbs. per min. of our particular engine at a given speed by the standard unit, there evolves a number which we have conveniently employed to rate engines. The standard was chosen in connection with the steam engine by James Watt who was seeking some term of comparison between his first engine and the horse power for which it was substituted. He found the maximum power that a London draft horse could produce for a short period of time and if he had an engine that could equal this power he would rate it at one horsepower. The power produced by the horse was about 33,000 ft. lbs. per min., so this was chosen as the unit of power and has since been accepted generally.

In order to have an accurate measure of an engine we must know the speed at which a certain horsepower is developed. For example, in the gasoline engine curves of Fig. 4, this engine is seen to develop 35 hp. at 1000 revolutions per minute; about 67 hp. at 2000 r.p.m.; about 82 hp. at 3000 r.p.m.; etc. These curves sometimes represent the maximum that the engine will do and sometimes are reduced to include a factor of safety. Here we enter the much discussed subject as to how an engine should be rated and manufacturers vary in their opinions and practice. The figures are called the *brake* horsepower to distinguish them as the output from another figure called the *indicated* horsepower, which is indicative on how perfectly or effectively the fuel is burned in the cylinder and is equal to the brake horsepower plus the friction horsepower or friction loss of the engine. The indicated horsepower is for the laboratory and not considered in engine application as the brake horsepower is the power that engine actually delivers for use. This brake horsepower is represented graphically in Fig. 5 by the area labeled, net work (gasoline engine). This engine converted 23 per cent of the heat value of the fuel into brake horsepower, friction horsepower loss was 7 per

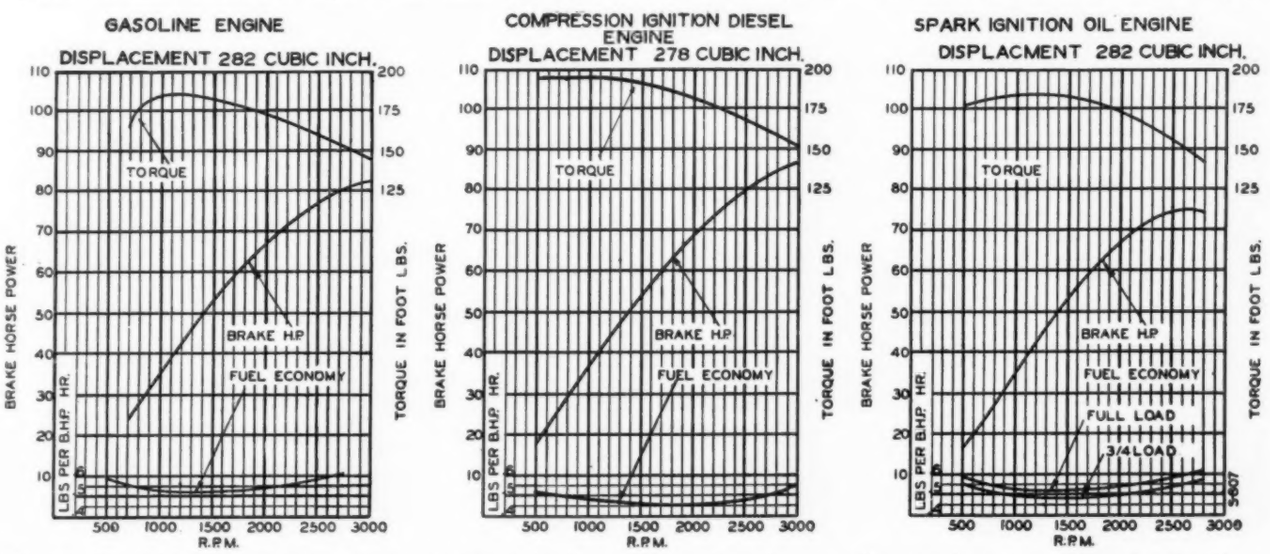


Fig. 4—Typical performance curves, prepared to the same scale, of a gasoline engine; a compression-ignition, or Diesel engine; and a spark-ignited, or Hesselman, oil engine showing horsepower, torque, and fuel consumption in a comparative manner. All three engines are of the 6-cylinder type, operate at similar speeds, and have practically the same piston displacement

cent, making the indicated horsepower 30 per cent of the possible, while 36 per cent of the heat units of the fuel were lost to the cooling water and 34 per cent to the exhaust gases.

Torque—The other word generally employed in speaking of power characteristics is the term, torque. Torque and horsepower differ in that torque is that turning moment or pull tending to turn the crankshaft about its center while horsepower can be derived from the torque at a particular speed by the consideration of the velocity factor or the rate at which the turning moment acts. In the gasoline engine, Fig. 4, the torque at 1000 r.p.m. is about 185 ft. lbs. This may be thought of as a pull of 185 lbs. acting at a radius of 1 ft. or a pull of 37 lbs. acting at a lever arm of 5 ft.—in either case the torque is the same. The torque may be thought of as independent of speed although the speed must be brought in to specify the point at which a certain torque exists but speed is not included in torque. The horsepower at 1000 r.p.m. may be derived from the torque by considering the force or turning moment as acting through a distance per minute equal to the r.p.m. multiplied by the circumference of the circle through which the pull is considered as acting. If we consider a pull of 185 lbs. acting at a distance of 1 ft., the horsepower equals $185 \times 2\pi r$ (or 2π) $\times$ 1000 divided by the unit, 33,000 or 35.2 hp. which checks with the power curve at 1000 r.p.m. It will be noted that the torque curve increases as the speed decreases (to a certain point). This means that the pull becomes greater as the speed is lowered and at the same time the horsepower becomes less, which indicates that the rate at which the torque acts is so much less that the horsepower is reduced while the torque is increased.

Power Requirements of Highway Machinery

Machines to be powered not only have horsepower requirements but torque requirements as well. The torque or load requirements of the various machines found in the highway industry may be divided into three classes:

(1) Those machines where the load or pull required decreases with the speed, such as centrifugal pumps and electric generators.

(2) Those where the load is a maximum at low speed and decreases as the speed is increased. This is a large and important grouping including trucks, tractors, industrial locomotives, excavators, hoists, etc.

(3) Those where load conditions lie between these two extremes.

Now unless a prime mover can be found that has the same torque characteristics as that required by the machine to be powered, some compromise solution will be necessary such as the interposition of clutches and transmissions. The steam engine may be described as having a very high stall and starting torque in any position (if of four or more cylinders), and decreasing with increasing speed. This is seen to be what is required of the machines in group (2). Therefore this large class of equipment logically belongs to steam power. The gasoline engine, on the other hand, possesses zero starting torque (or must be kept running to have any torque at all), good torque characteristics at the higher speeds down to 600 to 800 r.p.m. where it falls off rapidly in most cases. In the gasoline engine of Fig. 4, the torque curve begins to turn at about 1000 r.p.m. and at 700 r.p.m. is falling off rapidly. It can be seen from this that when the gasoline engine set off to conquer the steam unit in this field it was the case of a prime mover inherently unsuited to the power requirements of

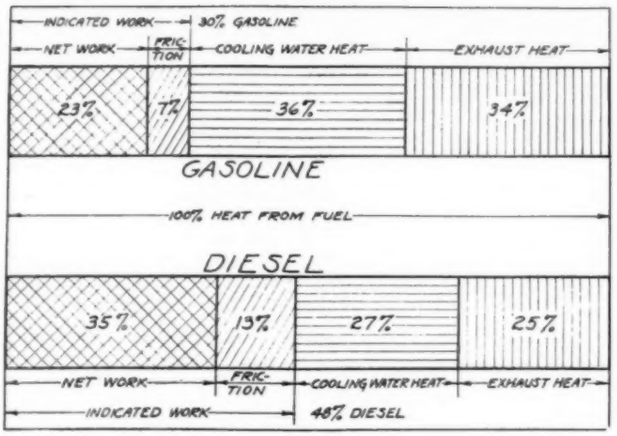


Fig. 5—Heat-balance chart showing an average distribution of the heat value of commercial gasoline in the gasoline engine and Diesel fuel in the Diesel engine. The increased efficiency or net work of the Diesel will be noted

machines against a power unit exactly suited in torque requirements to the machines.

As far as the first class of machines is concerned, the gasoline engine is ideal as the engine may be direct-connected and if suitable starting is provided the problems are essentially solved. Here the steam engine is not as suitable as the gasoline engine as for torque requirements. But if the gasoline engine is to displace steam in the second class of equipment, it must be advantageous enough to warrant the additional expense and inconvenience of the clutch and transmission. The gasoline engine so far excelled the steam engine in operating efficiency (some 20 to 25 per cent for the gasoline engine to some 4 to 8 per cent for the steam engine), in compactness for a given power, in avoiding many nuisances, in avoiding standby losses, and others, that it has been practically banished from highway equipment. In comparatively recent years the gasoline-electric drive has entered to add numerous advantages by furnishing power with proper torque requirements.

Early Application of Gasoline Engines

The steam traction engine was one of the early fields of mobile equipment invaded by the gasoline engine. At first there was merely a replacement of the steam engine by the gasoline engine during the nineties in the larger units. The early development in gasoline tractors was chiefly concerned with engine design, directed toward increased reliability and economy. On the crawler tractor, gasoline engines were first used in 1905 and did their first industrial work hauling materials in 1908 as shown in Fig. 1. Larger wheel-type gasoline tractors are illustrated in Fig. 2. A second period of tractor development might be thought of as that era when emphasis was particularly placed upon the running gear frames, the "frameless" type, transmissions, etc. A third period may be classified as the simplification process in eliminating as many parts as possible and design for straight-line production. Thus the tractor came to be dominated by the gasoline engine and achieved a high state of efficiency before the Diesel engine was seriously considered.

One of the first applications of gasoline engines to locomotives was probably in 1906. The advantages particularly in the smaller sizes such as employed in highway construction was so marked that the gasoline engine was increasingly employed generally with clutch and transmission drive but also with the electric drive in

some of larger units of this field. The gasoline engine locomotive could by gear changes be made to exert a larger starting pull than a steam locomotive of equal weight and this coupled with greater economy and other advantages has brought its conquest of these units.

Gasoline engines were early applied to centrifugal pumps where its torque characteristics were quite suitable. It was also soon applied to air compressors and in Fig. 6 are illustrated two portable compressors, the one produced in 1910 having a single-cylinder engine while the later model was powered by a 4-cylinder, 4½ by 6-in., 40-hp. gasoline engine. An early application of an internal-combustion engine to a concrete paver was made in 1916.

Due to the splendid convenience of gasoline power over steam power, it early entered the excavator application, probably in 1911. Since the use of the gasoline engine prevented the use of three independent power units such as had become standard with steam, it was necessary to revert back to the former design of driving the three functions through clutches. But the gasoline engine furnished advantages enough to warrant this although the progress was doubtless slower than in some other applications because of the flexibility of the steam unit. Probably during the years of 1917 to 1920, gasoline powered excavators for road construction reached a position of general acceptance and by 1927 steam power for these machines had become so far replaced as to be almost negligible. A return to the features of the three engine steam unit was made by a design brought out in 1925 and employed a gasoline engine-compressor unit. The hoisting, which requires the greater power, and the swing were driven direct from the engine by clutches while compressed air was furnished for a separate air engine (similar to steam engines in construction) to drive the crowd. This unit was powered by a 4-cylinder, 5¾ by 8-in. gasoline engine. Later another air engine has been added to operate the swing which requires flexibility next to the crowd. The exhaust heat from the engine was used to preheat the air entering the air engines. The gasoline electric shovel has also been generally applied to solve the power problem since the electric motor drive approximates the steam engine in torque characteristics.

Gasoline engines have been applied to a great diversity of equipment in the road field and the availability and development of different sizes of gasoline engines has given rise to further development of labor-saving devices which were not considered before a suitable power unit had been placed on the market. And to mention the truck brings to mind the fact that it never was a practical possibility before the advent of the gasoline engine and today the truck engine has achieved a high state of perfection.

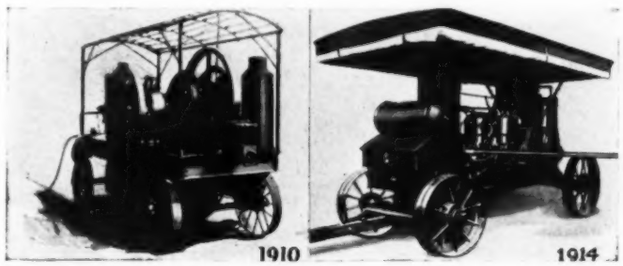


Fig. 6—Two of the earliest portable air compressors powered by internal-combustion engines, the 1914 model employing a 4-cylinder gasoline engine

The Carburetor and Induction System

The carburetor and manifolding system may be called the heart of the gasoline engine and the fuel situation absolutely governs its design. The carburetor has for its problem the vaporization and proportioning of the liquid fuel with the incoming air so as to form a combustible and efficient mixture. The earliest engines used gaseous fuels and needed merely a proportioning device, mixing approximately one part by volume of gas to eight parts of air, depending upon the gas used. But the inconvenience involved caused a turn to liquid fuels as the petroleum industry made them available. The same laws govern the fuel mixture and one of the prime requirements is that the fuels be vaporized and thoroughly mixed with the proper amount of air at the instant of ignition.

The science of carburetion is a profession in itself and many firms have been organized to offer nothing else but carburetor equipment. Carburetor development has been long and interesting. The essential principle has been the drawing of the intake air through a restricted passageway, indicated by arrowmarks in Fig. 7.

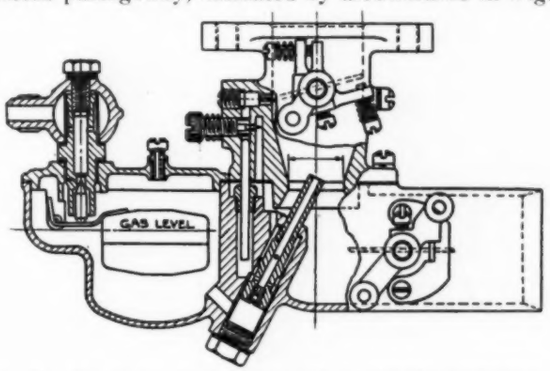


Fig. 7—Cross-sectional view of a simple compensated plain tube carburetor showing main fuel jet located in the restricted passageway and the auxiliary fuel feed for idling

A jet is placed in this passageway and the fuel level maintained by float arrangement somewhat below the jet tip. As air flows through the throat it increases in velocity with a pressure drop which sucks the fuel from the jet, mixing it with the air-stream in predetermined proportions. But since there is a tendency of the mixture to become richer with increased air velocity, it has been necessary to introduce some mechanism to compensate and various schemes have been devised, some of which were objectionable because of movable parts. The one illustrated is of the compensated or air-bled, fuel-jet type and also employs an auxiliary fuel feed above the throttle for idling.

Ideal engine performance may be outlined as including maximum horsepower output and flexibility with a minimum fuel consumption under the various conditions of operation. The resistance of the carburetor and induction system to the incoming mixture should be a minimum for maximum power, while compromises must be made for the sake of flexibility. The carburetor and manifolding must be worked out for a particular engine to obtain maximum performance and great progress has been made in bringing gasoline engine operation to its present perfection.

Gasoline Fuels and Octane Numbers

At the time of the early gasoline tractor, kerosene was largely used for illuminating purposes and was available everywhere. There was little demand for

gasoline at the time, so a large part of the engines were designed to operate on kerosene. The gasoline of the time was very volatile and of a high grade while kerosene gave good performance. The automobile brought a change in the industry and has so increased the demand for gasoline that the petroleum industry has come to the cracking process to obtain a greater yield of gasoline from the crude oil and consequently less kerosene. In many areas kerosene costs more than gasoline, which has caused a trend toward gasoline engines in tractors. The trend in the automobile industry has been toward higher compression ratios and their increased efficiency and doubtless the industrial and tractor engines are following the same trend as better fuels are made available.

The tremendous research carried out on gasoline fuels during recent years has come to the observation of the public under the term, octane rating or octane numbers. As the compression ratios of engines were increased to obtain increased power and economy, a definite knocking occurred under maximum power. This tendency to knock was noted to vary considerably with different gasolines of apparently the same physical properties. It became necessary to devise some means of rating gasolines as to their knocking tendencies. A special single-cylinder laboratory engine, properly equipped for obtaining performance data, was devised and standardized. The compression ratio could be varied by a mechanism and linkage while the engine was in operation. The method of comparison by trial was then adopted. All available hydrocarbons (or petroleum products of complex combinations of hydrogen and carbon) were studied to find the one that was the least susceptible to knocking or detonation when tried in the engine and at the same time was not too prohibitive in price. Octane was decided upon. It was also necessary to find a hydrocarbon that was the most susceptible to knocking or that knocked worse than any known gasoline. Heptane was found. By forming a blend between these two fuels it was found that the knocking tendency gradually became less as the percentage of octane in the mixture was increased. This meant that a particular gasoline could be used in the test engine at constant conditions and the compression pressure raised until a certain constant degree of knocking occurred. Now with the same compression pressure as produced the knock in the test sample and the same engine conditions, it is necessary to find by trial what particular percentage of octane in an octane-heptane mixture will produce the same degree of knocking as the test sample produced. This percentage of octane is the rating and so a gasoline may have an octane number of 60 or 70 as the case may be.

This has been a great achievement and has enabled the engine designer to produce an engine for a certain grade of gasoline. The trend has been toward higher octane numbers, which means a higher power and economy if the engine is designed to take advantage of these better fuels. There has also been considerable research on combustion chamber shapes in coordination with fuel development. Often it is economical to design industrial engines for low octane gasolines which may be considerably cheaper in certain areas.

General Improvement in Gasoline Engines

Besides the fuel and carburetor development, there has progressed a gradual improvement in better materials and manufacturing methods and the industrial engine industry has followed the automobile engine producers closely in engine refinement, bearing in mind that the industrial unit demands special considerations. There has been an increase of power per unit weight of engine due largely to fuel development, and consequent engine adjustment to employ these betterments, but also in a large measure to improved design details and production refinements. First, better materials have been introduced into manufacture and upon which refinements depend. This has enabled a general lightening of the structure of the engine.

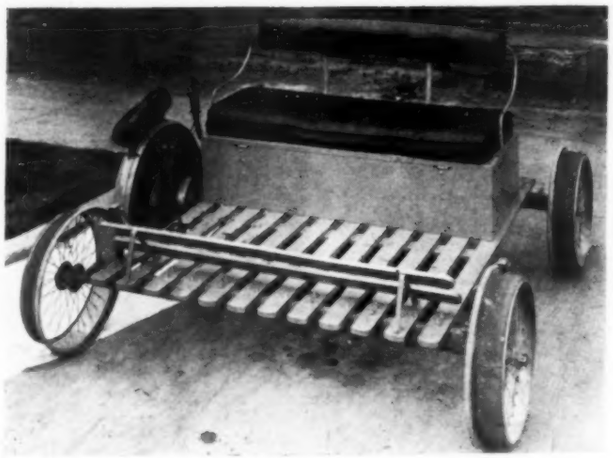


Fig. 8—An interesting application of a small Briggs and Stratton, ½-hp., air-cooled, motor-wheel type engine, designed for bicycles and other small vehicles, being applied to a railroad inspection car some 15 *years or so ago*

A most important phase of development has been in connection with cylinder construction. At first the block itself was finished to come in contact with the piston. Then the cylinder sleeve or removable liner of thin structure was forced tightly into a finished cylinder giving some improvement but yet not so satisfactory as the later refinement. It is firmly established that water leaking into the crankcase is a grave matter and thus much development was necessary for the introduction of what is called the wet liner construction. It means that the cylinder block becomes just a frame for housing the cylinder liners which themselves come in contact with the cooling water and thus get their name. The development of leak-proof packing joints was necessary before this refinement was possible. This type of construction is gaining popularity especially in the medium and larger engines of the road field and will be noted on many of the Diesel engines illustrated in that section. They have the advantage of uniform wall thickness and hence more uniform cooling, more accurate roundness which enables the pistons to be fit more tightly and the piston rings to seal the cylinder more positively, thus affecting particularly the oil consumption, which some say has been reduced about one-half during the past few years.

Another improvement has been the realization of the importance of valve construction and that of keeping the exhaust valve cool. It will be remembered that it is subject to the tremendous heat of the exhaust gases as they pass out of the cylinder. The alterations in design have had a general effect upon performance. Another matter is in connection with water cooling. It has been thought by some that cooling should be done by much circulation of hot water, which gives a more even engine temperature, rather than by circulating less and having the temperature difference between jacket and radiator water greater. Also the importance of avoiding the operation of engines at low engine temperatures have been observed and some disastrous results have been obtained when this factor was not heeded.

THE AIR-COOLED INDUSTRIAL ENGINE

WHILE the small air-cooled gasoline engines were developed with the object of supplying certain power needs, their having been made available gave impetus to equipment designers to produce all sorts of labor-saving machines to be used in highway construction. Needless to say the convenience of these small engines and their operated equipment is great. Possibly no one man is acquainted with all the applications of these units in the road field, their number and diversity being so outstanding. Some of the factors involved in air-cooled engine design will be discussed and some representative applications mentioned.

The Air Cooling Principle

It is naturally desirable in the internal-combustion engine to convert as large a percentage as possible of the heat value of the fuel into useful work. This can be done by permitting the highest possible temperature and pressure conditions in the cylinder. The increased temperature produced by combustion causes expansion which in turn causes pressure rise, because the volume was held nearly constant for the instant. This pressure acts upon the piston doing work. The temperatures of the fuel-air mixture entering the cylinder may be as low as 100 deg. F. while the products of combustion may rise to an instant temperature of about 3000 deg. F. at full load. The heat is transferred to the cylinder walls direct and through the piston and rings during the compression, explosion, and exhaust strokes while heat is transferred the reverse to the entering mixture during the intake stroke. It is manifest that no oil film can remain on the cylinder wall exposed to such high temperature unless the wall be kept cool. Likewise the metal would be quickly ruptured. Therefore heat must be conducted away from the cylinder walls by some cooling medium, which represents a direct loss. It will be recalled that the heat balance of Fig. 5 showed that for that particular gasoline engine the cooling water loss was 36 per cent. The engine gave up this percentage of its heat to the jacket water which in turn gave up its heat to the air passing through the radiator and was again circulated through the engine.

A few figures may impress us with the amount of heat to be conducted away from the cylinder of an air-cooled engine assuming the figure of the larger water-cooled engine of 36 per cent loss. An engine developing 8 hp. at 2200 r.p.m. consumes about 0.70 lbs. of gasoline per horsepower per hour or a total of 8×0.70 or 5.6 lbs. per hr. This gasoline has a heat value of approximately 19,000 B. T. U. per lb. of fuel. (A British Thermal Unit is that amount of heat required to raise 1 lb. of water 1 deg. F. or 1 lb. of fuel has enough heat to raise 19,000 lbs. of water 1 deg. F. if it could all be utilized.) Since the engine at full load uses 5.6 lbs. per hr., it receives about 106,000 B. T. U. per hr. or about 1750 B. T. U. per min. We have assumed that 36 per cent of this heat had to be removed by the cooling system or approximately 630 B. T. U. per min.

Experience has demonstrated that the transfer of this heat through the cylinder walls is sufficiently rapid but that if air cooling is to be used, an area greater than that of the simple cylinder must be exposed to the cooling air. Since cooling is proportional to the surface area exposed, an artificial area is constructed with fins about on inch deep extending all around the cylinder and head. For air-cooled engines used in vehicles, as illustrated in Fig. 8, the motion of the motor through the air causes sufficient air circulation about the fins to cool the engine. But in the industrial engine special means must be provided for supplying and directing the air about the fins. As a flywheel is required, it has been found efficient to construct a flywheel with vanes which draws in air at its center and delivers it through sheet-metal enclosure about the cylinder. The air cooling can be worked out very accurately by experiment.

There is a necessary bulk and weight involved in the water-cooling system which increases in proportion to engine weight as the units become smaller. Also the matter of cost of the cooling system along with its needed precaution in winter to prevent freezing. These reasons along with possibly others have led designers of small fractional up to 6 or 8-hp. gasoline engines to perfect the air cooling principle. It is significant that

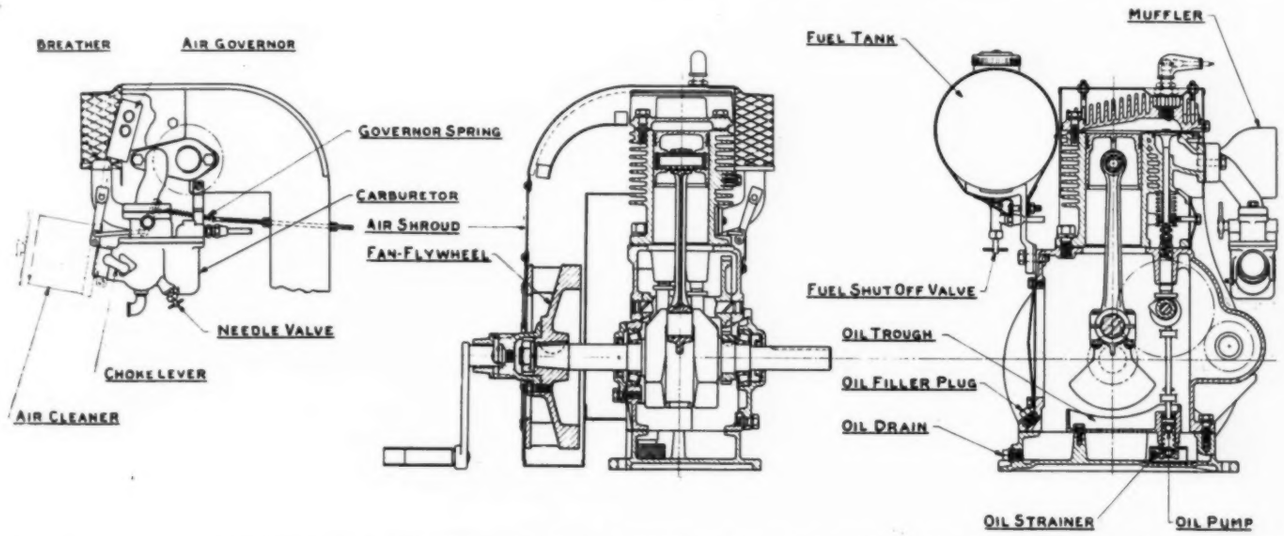


Fig. 9—Cross-sectional views of a Wisconsin single-cylinder, air-cooled engine, showing general construction and air cooling. To the left is a sketch of the carburetor, the air shrouding arrangement, and the air governor

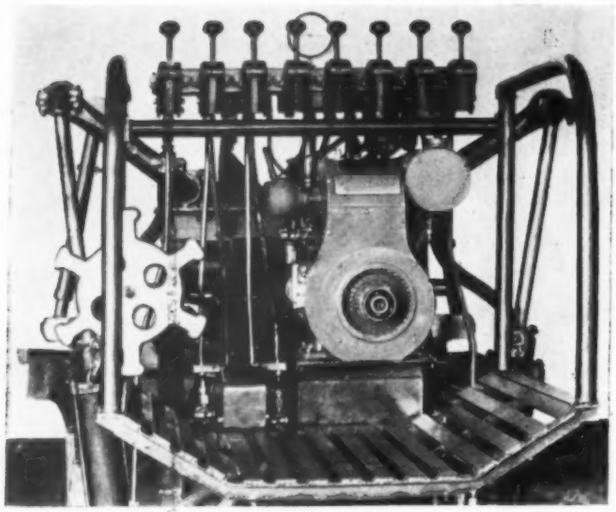


Fig. 10—*View of the operating platform of a road grader showing a 6-hp., air-cooled engine mounted in the chassis used to operate a hydraulic system for raising and lowering the scraper blades and otherwise adjusting the machine*

these designs first appeared in the smaller sizes and then have increased somewhat.

Development and Application

Air-cooled engines have been widely and successfully applied in other fields but perhaps one of the forerunners of the small industrial engine was the unit designed to operate principally on bicycles. It was a self-contained unit having its own wheel and was mounted on the rear side of the bicycle. It employed an automatic spring-loaded inlet valve and cam-operated exhaust valve. It was brought out about 1914 and flourished well until most of the states passed laws about 1917 preventing children from operating motor-bicycles. This largely killed the motor business and led to the adaptation of the design into an industrial power unit in 1919 for washing machines, milking machines, etc. As more applications developed, larger engines were brought out. About 1925 a 1½-hp. engine was produced with garden tractors in

Fig. 11—*Operating scene of a highway surfacing machine having a 5-hp., air-cooled engine mounted integral with the machine. It is equipped with a blower arrangement for conducting the grindings away from the engine and operator*

view and was soon after applied in the road industry. As an illustration of development, the motor-wheel engine having a bore and stroke of 2¼ in. and thought of as a ½-hp. engine, was for special government service redesigned using special alloys. This enabled it to be operated driving a generator at about 4,000 r.p.m. and developed about 2 hp. The government used a large number of these units for lighting and power sets for portable radio application.

An interesting application of the air-cooled engine is found in the road grader where it is mounted in the chassis of the grader directly in front of the operator's platform, as shown in Fig 10, and used to operate a hydraulic pump which supplies liquid under pressure to various pressure cylinders for controlling the position of the grader blade and the other adjustments of the grader. The small levers are the controls for directing the liquid into the various cylinders. The early graders employed manual control while later the hydraulic system was installed with the hydraulic pump connected and mounted to the tractor power take-off. Another typical installation is shown in Fig. 11. The machine is a highway surfacer used for resurfacing and repairing concrete pavement. The engine is incorporated into the machine with a blower arrangement for removing the

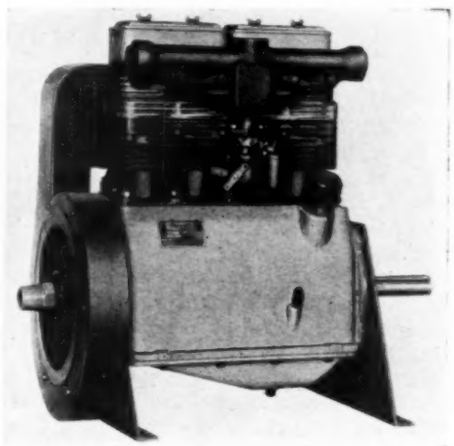


Fig. 12—*Side view of the Wisconsin 4-cylinder, air-cooled, overhead-valve industrial engine showing the air shroud which is constructed around the back of the cylinder block directing the air about the cylinders through the fins toward the front. The flywheel-fan in the housing takes its air through the grid*

material as it is ground. Among the numerous other applications the following may be mentioned: centrifugal pumps, generator sets, compressors, conveyers, flexible-shaft machines to which is attached many different tools, oil-burning equipment, sprayers, highway mowers, blowers, concrete mixers, welders, portable unloaders, gravel spreaders, etc.

Construction Peculiarities and Features

The air-type governor, illustrated in the diagram of Fig. 9, is of interest as providing a cheap and fairly accurate means of governing the engine. The vane of the governor is seen partially obstructing the outlet from the air duct and is fastened to a lever which is connected to the throttle arm. The vane has a motion outward from the position shown and must stretch the governor spring which may be adjusted for tension. As the speed of the engine is increased, an increasing amout of air flows through the shrouding against the perforated vane forc-

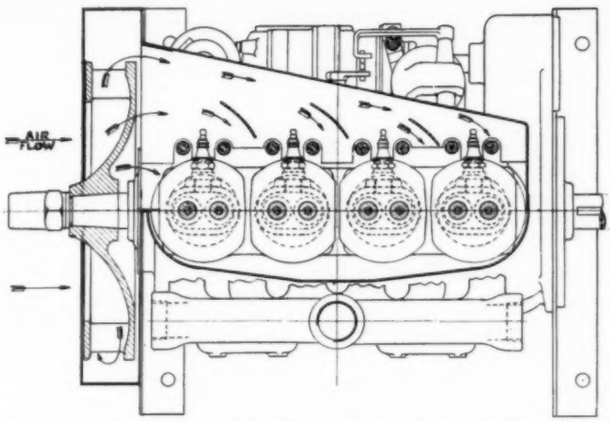


Fig. 13—A section taken through the valve ports of the engine looking downward with the main object to show the fan and shrouding arrangement which will be noted is tapered toward the far end with baffles to direct the air about the cylinders. The cylinder, valves, and combustion chamber are shown in dotted lines while on the far side will be noted the governor and magneto

ing it outward which in turn closes the throttle, or as the speed decreases the air flow is decreased and the spring returns the vane thus opening the throttle, as the case may be, until equilibrium is reached.

These engines are furnished so that a centrifugal pump, for example, may be mounted with the vane fastened directly to the crankshaft and the pump housing upon a machined flange of the crankcase making a compact unit. They are often equipped with reduction gearing and also with clutch power take-off attachments. The ignition systems employed are of the flywheel type and the unit type with separate drive. These engines are generally furnished for gasoline operation although they can be adapted to operate on No. 1 fuel oil, natural or manufactured gas, propane or butane, etc.

An economic factor that should be considered by those who are operating a large gasoline engine for small power operations is the fact that at very low power of a particular engine its fuel consumption per horsepower-hour is very high. If one should plot a curve of lbs. of fuel per hp.-hr. against per cent of rated power, such as in Fig. 46, he would observe that the fuel consumption in lbs. per hp.-hr. at 10 per cent rated power might be many times that at the higher loads. If engines are operated at long periods at these light loads, it might be profitable to supplement the larger engine by a small one to care for the light loads where it can operate at a higher efficiency.

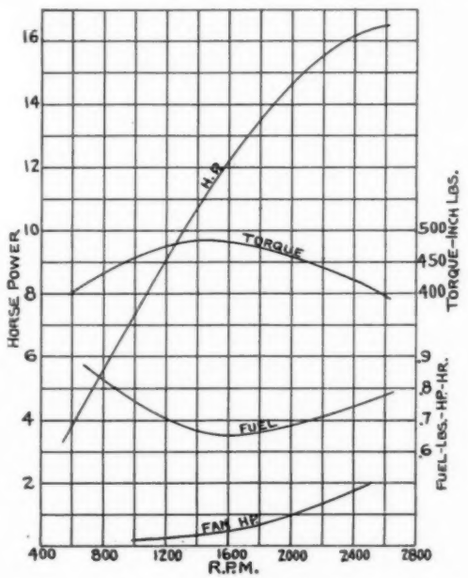


Fig. 14—Power curves of the 4-cylinder, air-cooled engine showing the horsepower, torque, and fuel consumption and also the power consumed by the flywheel fan at various speeds

A 4-Cylinder Air-Cooled Engine

The power applications of air-cooled engines have been enlarged by the introduction of a 4-cylinder unit (Fig. 12). It has 2⅝ by 3¼-in. cylinders cast enblock with overhead valve design. The overhead valve type was resorted to for two reasons: (1) the cooling air could more readily be directed about the cylinders than in

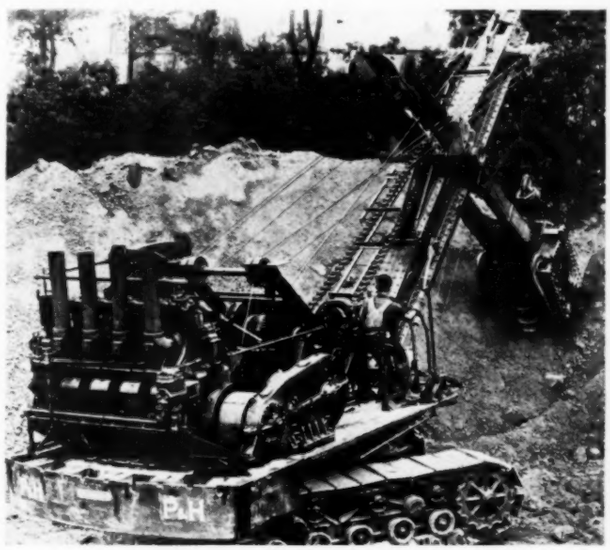


Fig. 15—An excavator being powered by a 4-cylinder Diesel engine showing controls, engine mounting and drive, radiator, etc.

the L-head design. In the single-cylinder engine of the L-head design (Fig. 9), it will be seen that the air is directed from the side of the cylinder, striking the exhaust valve, passing between the valve and cylinder through openings and over the top of the head. When the multi-cylinder engine is considered, it is noted that the air must be directed from the back through the cylinders to the front and not from the side. This creates greater problems with the L-head type. (2) It was found more practical from the foundry standpoint to employ the overhead-valve design.

The drawing of Fig. 13 has been made to show the flywheel fan, the sheetmetal shrouding, the baffle plates, the cylinder arrangement, and the airflow. The cooling air is directed up through the riser to the horizontal encasement as indicated in Fig. 12. This casement has as its purpose to equally divide the air between the cylinders and is therefore tapered from rear to front. Vertical baffle plates are placed in proper positions to cut off a portion of the air for each cylinder and direct its motion across the engine through the cylinders and out on the open side of the cylinders (Fig. 12).

The performance curves for the engine are plotted in Fig. 14 with an added curve of the measured horsepower consumed by the cooling fan.

THE HIGH-SPEED DIESEL--AND OTHER OIL ENGINES

THE Diesel engine may be defined as an internal-combustion engine employing liquid fuel injected directly into the cylinder and depending upon the heat of compression for ignition. It is an internal-combustion engine because the fuel is burned in the working cylinder. It is a fuel-injection engine in contrast to a carbureting engine, the fuel being injected into the combustion chamber under high pressure by a suitable injection system. It is a compression-ignition engine in contrast to the spark-ignited engine. On the intake stroke air only is drawn into the cylinder and compressed in contrast to the fuel-air mixture being drawn in and compressed as in the gasoline engine. Much higher compression pressures are used in the Diesel which must be at least high enough to raise the temperature of the air compressed in the cylinder to a point where ignition of the fuel will occur spontaneously upon injection while, in contrast, the compression pressure of the Otto-cycle or gasoline engine must not be so high as to ignite the fuel-air charge being compressed in the cylinder by the temperature of compression, ignition being by carefully-timed spark. The Diesel engine compression pressures then must be in excess of a certain minimum amount while the gasoline engine compression pressures cannot be over a certain maximum amount.

Diesel and Gasoline Engine Efficiency

The efficiency of any machine may be defined as the ratio of the energy or work that is gotten out of a machine to the energy put in. For an engine it is a ratio of the power output to what the power output might have been if all the heat energy of the fuel consumed could have been transformed into mechanical power. This will always be less than 100 per cent for any machine according to the laws of thermodynamics. All the heat units of a pound of fuel burned in the cylinder must be accounted for as useful work and losses, as was referred to in the gasoline-engine discussion (Fig. 5), and such an analysis is called a heat balance or an accounting for the expenditure of heat. There is charted in the same figure for comparison a typical heat balance of a Diesel engine. It is seen that the Diesel efficiency is represented as 35 per cent with the other losses correspondingly reduced, with the exception of the friction loss of the engine which is materially increased for the Diesel. This increased efficiency of the Diesel over the gasoline engine is attributable to the increased compression pressures employed. In other words the Diesel produces more power from a pound of fuel or consumes less fuel per horsepower than the gasoline engine because its cycle of operation is such that greater efficiency is obtained. This may be observed by reference to Figs. 4 and 46.

It will be recalled that in connection with Otto-cycle development, Beau de Roches in 1862 declared the desirability of compressing the fuel-air mixture to its highest possible degrees to increase efficiency. This was a most important discovery and has remained incorporated in engineering and design. While the progress of fuels and combustion-chamber forms for gasoline engines has incited considerable tendencies toward increased compression and consequently higher efficiency, the carbureting engine is limited in what efficiency can be attained because of its limited compression pressure. The Diesel, on the other hand, is limited in what compression pressure shall be used only by constructional requirements and costs. The usual compression pressure employed is slightly above that required for temperatures to ignite the fuel. A price must be paid for this higher compression of the Diesel engine in that the engine must be heavier throughout than its gasoline competitor to withstand the increased stresses.

The Diesel Cycle of Operation

In order to better understand the operating differences of the gasoline- and Diesel-engine cycles, the sketches in Figs. 16 to 19 are presented. Both cycles require four strokes of the piston for their completion and both include the intake, compression, power, and exhaust strokes. The general construction of the cylinders and valve gear are similar. With the inlet valve open, as in Fig. 16, the gasoline engine draws in an amount of air through the air cleaner which picks up gasoline vapor in the carburetor, thus filling the cylinder with a combustible mixture. The Diesel on the other hand has no carburetor and draws in a charge of air only into the cylinder.

The compression stroke follows (Fig. 17). The compression pressure of an engine depends upon the compression ratio and must be built into an engine. The compression ratio is the ratio of the total volume (cylinder displacement plus clearance volume) to the clearance volume, and is about 5 to 1 for the gasoline engine and 15 to 1 for the Diesel. In the gasoline engine the fuel-air mixture is compressed to some 75 to 100 lbs. per sq. in. while in the Diesel the air alone is compressed to some 500 to 575 lbs. per sq. in., which raises the temperature of the air to some 1,000 deg. F. At the end of compression (Fig. 18) the charge is ignited by an electric spark in the gasoline engine. In the Diesel, with the air at this high temperature, a charge of solid fuel is injected and instantly ignites giving the pressure rise and power stroke. The fuel oil used in the Diesel if heated to about 675 deg. F. will ignite if sufficient air is available, so there is usually some margin of safety provided which also aids combustion. The exhaust strokes (Fig. 19) of the two engines are similar with

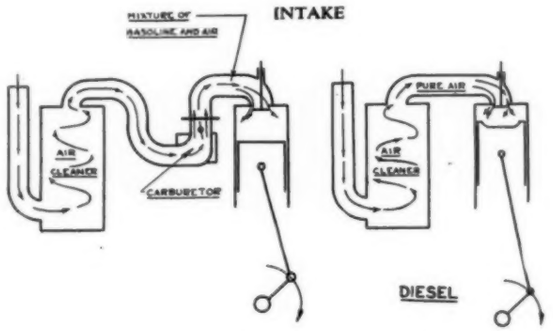


Fig. 16—Diagrammatic sketch of the intake stroke of a gasoline and a Diesel engine illustrating their differences

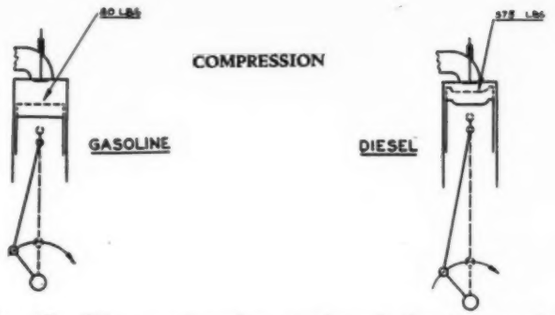


Fig. 17—The compression stroke of the two engines, which is the same except for the pressures

the exception that the gases are somewhat cooler for the Diesel due to more complete expansion.

History and Application of the Diesel Engine

The Diesel engine derives its name from a German scientist and inventor, Rudolph Diesel, who in 1893 patented his theory of a compression-ignition engine with fuel injection including the idea of slow burning of the fuel. It is said that his original engine employed a compression pressure of 2,000 lbs. per sq. in., but was abandoned because impractical. He then used about 500 lbs. per sq. in. and completed his first practical engine in 1897 employing an air blast to inject the fuel and was of very heavy construction. Important development of stationary Diesels took place during the early years while during the World War Diesels became important for submarine application. The medium-speed Diesel was evolved and it was these units that were first applied to road building equipment. It is said that the first Diesel shovel was built in 1922 while previous to this, in 1912, a large dragline was powered by a semi-Diesel engine which burned distillate. A Diesel plus air shovel was first built in 1927.

But the Diesel engine of the high-speed type, such as has come to be applied in so many portable machines, began to be developed in Europe about 1925 and the weight per horsepower has been reduced from 400 lbs. per hp. or so to something less than 20. If it be asked why the Diesel-engine development for such service lagged so behind the gasoline engine, three reasons have been stated: (1) Economy has never been the great issue in gasoline engine development; (2) the available heat energy of the gasoline engine was accessible and more easily controlled; and (3) because of the profound engineering problems connected particularly with the small Diesel, many of which could not be solved until recent technological developments.

The Diesel engine was not applied on any extensive

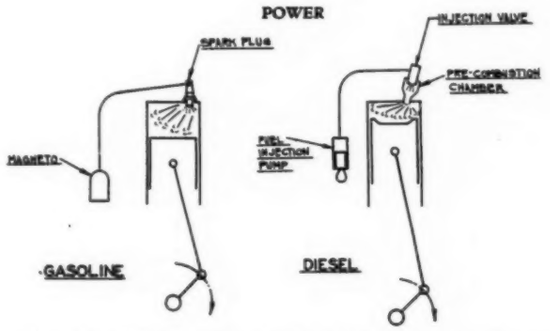


Fig. 18—The power stroke of the two engines

scale to tractors until less than 5 years ago although much experimentation had been carried on previously. This application has rapidly increased until during the past year one manufacturer offering a selection of gasoline or Diesel powered tractors reports that 9 out of 10 tractors sold in the larger sizes were Diesels. The application of the Diesel engine to trucks on any extensive scale is also well within this period while experimental units extend back some few years more. A list of the machinery employed in the highway industry to which the Diesel engine has been applied may be of interest, as follows: power shovels, draglines, and backfillers; trucks and special earth-moving dumping units; tractors; industrial locomotives; road maintainers; road rollers; air compressors; elevating graders; concrete

Fig. 19—In the exhaust stroke, the burned gases are exhausted in a similar manner

mixers or pavers; ditching machines; centrifugal pumps; electric generators and welders; hoists and cableway excavators; snow plows; street sweepers and cleaners; bucket loaders; gravel plants and rock crushers; large road-mix plants, etc.

Torque Characteristics.—In the entry of the Diesel engine into these many types of machines there has been the primary consideration of economy of fuel cost. But another prime factor of considerable importance is the general torque characteristic of the Diesel engine. It will be noted that most of the machines listed above fall into the second class as to power requirements, as previously discussed, or those where the load is a maximum at low speed and decreases as the speed is increased. Close comparison of the Diesel and gasoline engine curves of Fig. 4 indicates that the torque curve of the Diesel is somewhat higher than that of the gasoline engine and in shape the two are somewhat similar until speeds approaching 1,000 r.p.m. are reached, below which their shape differs showing an important factor. As the ideal is the steam engine with its maximum starting torque, any approach in this direction will aid materially. This characteristic of the Diesel engine gives it a greater pulling power or lugging power at low speeds and will carry its load at a lower speed than the gasoline engine. Some have gone so far as to say that even if there were no difference in fuel costs between the two types of engines, the increased cost of the Diesel would be justified for many of this class of installations. It should also be noted from Fig. 4 that the horsepower curve of the Diesel is above that of the gasoline engine for practically the same cylinder displacement.

Two-Cycle Diesel Engines.—It was mentioned that early in gasoline engine development there was produced an engine that performed the four operations of intake, compression, power, and exhaust in two strokes of the piston. The two-cycle Diesel engine has been more practical than the two-cycle gasoline engine for the reason that air only must fill the cylinder of the Diesel. This principle has been extensively used for the larger power plant Diesels and in recent years has been em-

ployed in units so small as locomotive and railtrain engines while engines of the class here concerned with are all of the four-cycle type. The two-cycle engine has marked advantages but also great problems. The operation may be understood from the sketches in Fig. 20. The piston uncovers ports in the cylinder wall which are used instead of valves in this design. Others employ valves and port combinations. Compression will begin when the piston closes off the ports, the trapped air being brought to a temperature high enough to ignite the fuel when it is injected. Expansion follows, Fig. 20 (*right*), until the piston uncovers the exhaust ports when the pressure forces a good part of the gases out of the cylinder. An instant later the air inlet ports are uncovered admitting air, compressed slightly and called the scavenging air, which is directed upward by the piston clearing the cylinder of the remainder of the exhaust gases and leaving it filled with air which is again compressed and the cycle repeated. The scavenging air must be furnished by a compressor or some other means as in the case illustrated where the enclosed crankcase serves to slightly compress the air for scavening. Its action is plain—when the piston closes the ports on its upward stroke a slight depression is formed in the crankcase causing air to be drawn in through the automatic valve as shown in Fig. 20 (*left*). As the piston moves downward the air is compressed reaching a maximum at the instant the scavenging air ports are uncovered when it flows as outlined.

Fuels for High-Speed Diesel Engines

There exists a great error in the minds of many that the Diesel is an engine that will burn most any kind of fuel and is not at all particular as to quality. While

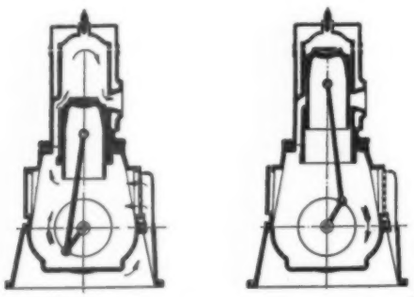


Fig. 20—Diagrammatic sketch of a two-cycle Diesel engine which offers a power impulse during each revolution of the crankshaft.

the large power plant Diesel may burn a large variety of fuels, provided they be thoroughly cleaned and certain harmful impurities removed, the high-speed Diesel generally requires a high grade of fuel oil well prepared by purification and chemical treatment. The various parts of the injection apparatus are of such fine and accurate structure that thorough cleansing from dirt and grit and harmful chemical elements must be carried out to preserve these parts as well as the engine in general. The petroleum industry has made marked progress in the study of high-speed Diesel fuels and the impurities that are economical to remove—particularly in the specification, standardization, and distribution of fuel oils.

Crude petroleum or crude oil can hardly be regarded as a Diesel fuel and certainly not for the high-speed Diesel as it contains water in emulsion and compounds that would cause rapid deterioration if successful combustion can be obtained at all. The character of crude oils naturally varies considerably according to its constituents. They are therefore refined. This is a process of distillation carried on in closed chambers, the more volatile compounds being given off first and gradually the less volatile. The great demand is for gasoline which is driven off from the crude at comparatively low temperatures. The advent of the cracking process has enabled refiners to obtain a greater percentage of gasoline from the crude oil by using the lower cuts—blending and treating them so as to convert about 60 per cent of the original volume of crude oil into gasoline. The next range is that of kerosene which, while not so desirable as gasoline, has been extensively used because of its lower price. The denser liquid remaining is the fuel oil which is treated and purified for Diesel application. If this liquid be distilled still further, the lubricating oils are driven off leaving a residue. The fuel oil is low in quality when compared to the gasoline and there-

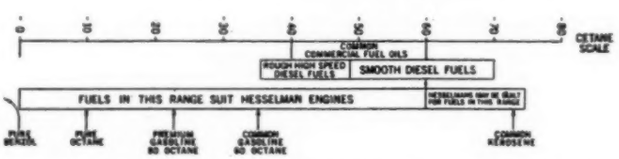


Fig. 21—Graphical representation of the Cetane Scale, a procedure devised for classifying the ignitability of Diesel fuels.

fore cheap while another feature is its greater density or greater weight per gallon while a pound of Diesel fuel has about as many heat units in it as a pound of gasoline.

The Ignition Quality.—In the carbureting engine where the air and fuel are thoroughly mixed by the time the spark occurs, the problem is one of making the fuel burn more slowly to avoid detonation. This was accomplished by the addition of the compound, tetraethyl lead and by a great amount of fuel research. The octane rating was developed to rate gasolines in this most important quality. But in the Diesel the mixing of the fuel and air must be accomplished within the cylinder by injection means or turbulence and engineers are much concerned that the fuel should have the quality of easy ignition. This has become by far the most important fuel specification for high-speed Diesel engines. Some of the most desirable characteristics in a gasoline have been found to be undesirable in Diesel fuels and vice versa. The test engine that was mentioned for use in the octane rating of gasoline has been converted into a Diesel engine with a variable compression feature for use in rating the ignition quality of Diesel fuels. If a fuel has poor ignition qualities, there will be a slight delay of ignition when it is injected into the cylinder causing an accumulation of unburned fuel which will ignite enmass when ignition does occur giving an audible knock and rough running of the engine. The better the ignition properties of a fuel, the better the operation. Different combustion chambers have been designed to accommodate this lack of good fuel quality and is a case of attacking the problem from a different angle.

The Cetane Scale.—If fuels are to be rated according to ignition qualities by means of the modified test engine, there must be found two hydrocarbons that have opposite ignition qualities that might be blended in various ratios to equal the ignition quality of a test fuel and thereby form a simple rating number similar to the octane number. Without tracing its achievement, the hydrocarbon cetane has been decided upon as the reference fuel possessing extremely rapid ignition properties while alpha methylnaphthalene has been chosen as the reference fuel with extremely slow ignition properties.

The test is conducted with the fuel desired to be rated until certain observations have been made and then the problem is to match this operation, which is indicative of ignition quality, by varying the proportion of the two reference fuels. When a match is obtained, the percentage of cetane in the mixture of the two becomes the measure and is expressed in a cetane number. Fuels may then be charted on a scale accordingly, as in the upper chart of Fig. 21, and specified as a Diesel fuel with a certain cetane rating. This development along with many others has aided the Diesel engine manufacturer and operator in knowing what fuels are available and what operation to expect from their use. Further development in Diesel fuels have immense possibilities and not many would venture to prophesy the future of fuels and combustion-chamber design.

Fuel Supply Systems for Portable Diesel Engines

Having introduced the subject of fuels, we shall now turn to the utilization of these fuels in existing high-speed Diesel engines. An endeavor shall be made to follow its logical order through the engine. The subject may be divided into four sections containing the four essential elements or parts of a fuel system, namely, the fuel supply system; the fuel-injection pump; the fuel-injection nozzle; and the combustion chamber. By referring to Fig. 22, it will be seen that the fuel supply system delivers the fuel through pipeline (*3*) to the fuel header of the injection pump (*C*) which meters and supplies the fuel at the proper instant through pipeline (*4*) to the injection nozzle (*5*) and is forced into the combustion chamber where it spontaneously ignites in the Diesel type.

The object of the fuel supply system is to furnish to the fuel pump, under a slight pressure that will assure complete filling of the plunger cavities, a fuel that has been filtered and is free from injurious particles. The fuel supply system consists of a fuel tank, a transfer pump, and one or more filters which may be of varied design. The importance of fuel filtering is very great and more so than in the gasoline engine. It is particularly easy for a fuel to become contaminated under the conditions usually found about road machinery. Several filters are therefore usually employed of increasing fineness. From the fuel tank, the fuel is often drawn through one or more filters before coming to the fuel-

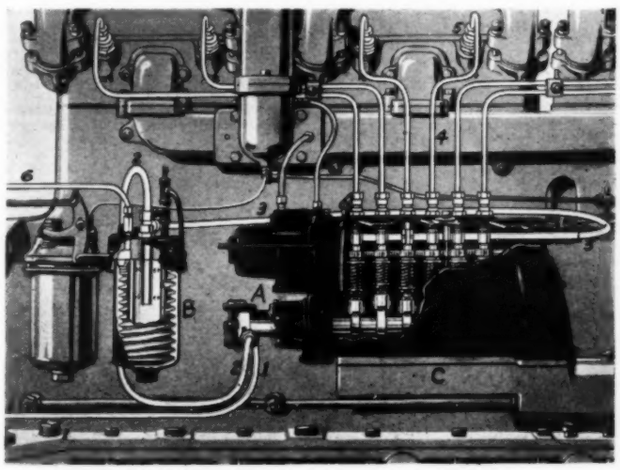


Fig. 22—Typical filtering and injection system showing the fuel-transfer pump (A), the fuel filter (B), and the injection pump (C), along with their connections.

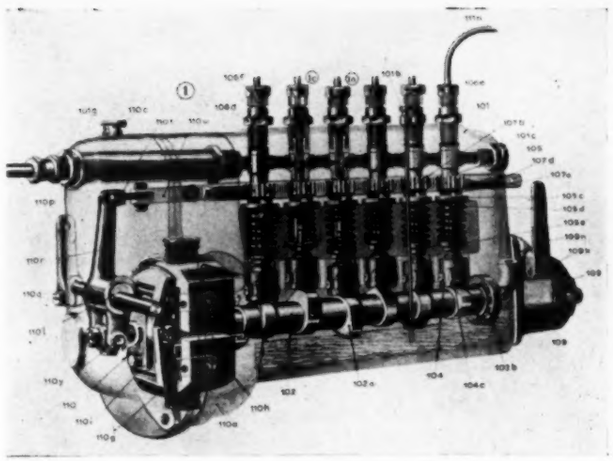


Fig. 23—Phantom view of a Bosch injection pump and governing mechanism for a 6-cylinder engine. Note that the governor arm operates the rack which engages the pinions of each unit simultaneously, thus varying the amount of fuel injected to each cylinder while keeping the balance equal between cylinders.

transfer pump through pipeline (*1*), Fig. 22. It is delivered through (*2*) under a pressure of about 15 lbs. per sq. in. to the final fuel filter (*B*) and then through (*3*) to the header of the injection pumps (*C*). But as a variable amount of fuel is demanded either a variable output pump must be used or another means such as shown. A pressure relief valve is provided which maintains constant pressure on the line leading excess fuel back to the fuel tank through line (*6*).

The Fuel-Injection Pump

Fuel-injection pumps for high-speed Diesel engines may be divided into two or more groups: (1) those whose function it is to meter the proper quantity of fuel and inject it into the combustion chamber (through either the open-type or closed-type, hydraulically-operated nozzle) at the proper instant and at the proper rate; (2) those whose function it is merely to deliver fuel to a fuel header under high pressure and require no metering or timing features; and (3) special types. Since the pumps of the first group are used by nearly all the manufacturers of the type of Diesel engines under consideration, the description will be limited to this type. As the Bosch pump has been adopted for the majority of engines of this class, its description will serve as typical of Diesel-engine fuel-pump operation.

From Fig. 22 it is noted that one pump unit must be used for each cylinder and these units are either gathered together in one pump housing, as shown in Fig. 23, or they are placed individually along the crankcase of the engine directly below each nozzle, as in Fig. 32. The former has come to be the most common practice. The various plungers are given a constant stroke by the various cams on the same shaft. The plungers and barrels are specially constructed to such close limits that no pump packing is necessary. The pressures in the injection line have been computed to be from 1,000 to 6,000 lbs. per sq. in. and sometimes even more so the necessary construction can be somewhat appreciated. By close examination of Fig. 23, it will be seen that a small pinion fastened to each pump plunger matches with a rack which in turn is connected to the governor or hand control. When the rack is moved longitudinally all of the plungers are rotated simultane-

ously in one direction or the other, as the case may be, which is the scheme for varying the amount injected.

In Fig. 24, there is drawn a plunger and barrel and shown in various position. In position (*1*) it will be seen that the plunger is provided with a vertical channel extending from its top edge (*A*) to an annular groove (the upper edge *B* of which is formed as a helix) a little way down the plunger length. At the proper instant the cam moves the plunger up through the barrel (which has previously been filled with fuel) and when the surface (*A*) covers the ports in the barrel, fuel is forced through a check valve above the pump barrel, through the piping to the nozzle and into the cylinder. As long as the ports remain covered the plunger will deliver fuel into the cylinder. But the helical edge (*B*) soon uncovers the port which causes an instant pressure drop, closing the injector and the check valve, while the plunger returns. In (*3*) and (*4*) are similar sketches showing the plunger rotated. The beginning of injection will be the same but the helical edge will uncover the port earlier in the stroke thus giving an earlier cutoff and less fuel. In (*5*) the plunger has been rotated all the way causing the port to remain uncovered and so no fuel is delivered.

The Fuel-Injection Nozzle

Fuel-injection nozzles may be divided into three groups: (1) The hydraulically-operated valve; (*2*) the open nozzle; and (3) the mechanically-operated valve. Since the hydraulic type is in most common use coupled with the type of pump just outlined the description will be limited to it, although mention of the other types will appear later. The valve is illustrated in Fig. 25 and is seen to be a differential needle valve which is spring loaded. The tip of the nozzle is made in different styles to accommodate various combustion chambers. The one illustrated is of the pintle type a portion of the nozzle valve projecting through the nozzle body. When this is lifted, injection will occur. The construction may also be of the hole type and may have a single hole or several holes (as in the sketch, Fig. 26). This sketch illustrates the differential pressure action which lifts the valve from its seat against spring pressure and holds it so until the line pressure collapses through pump cutoff. The fuel passageway (which is always full) leads the fuel to the nozzle tip where it has an active annular area tending to lift the pintle as indicated. When the pump raises the pressure sufficiently to raise the pintle by hydraulic pressure, injection begins. But when once the pintle has been forced open, the effective area which tends to hold it open is increased as shown thus aiding in holding it open as long as desired.

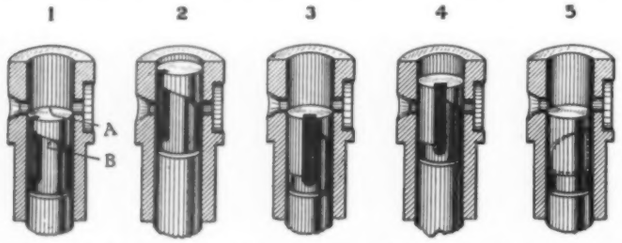


Fig. 24—The regulating plunger of the Bosch injection pump shown in different positions in its cylinder: (1) and (2) show the positions of the plunger for maximum delivery at the bottom and cut-off positions, respectively; (3) and (4) shows its position for normal load at the bottom and cut-off positions, respectively; (5) shows the plunger in off position where it will deliver no fuel during its stroke.

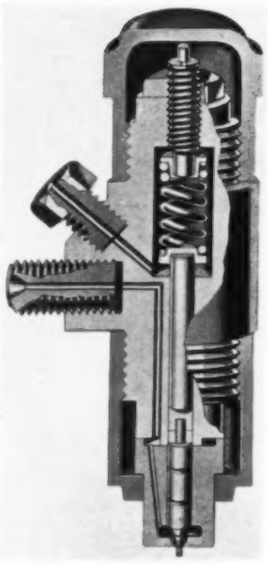


Fig. 25 — Cutaway section of the Bosch closed-type, single-orifice injection nozzle.

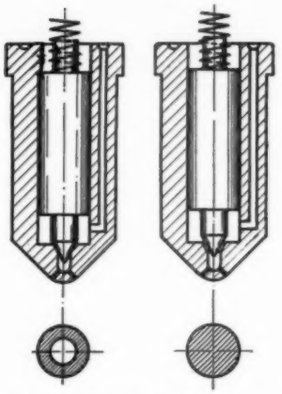


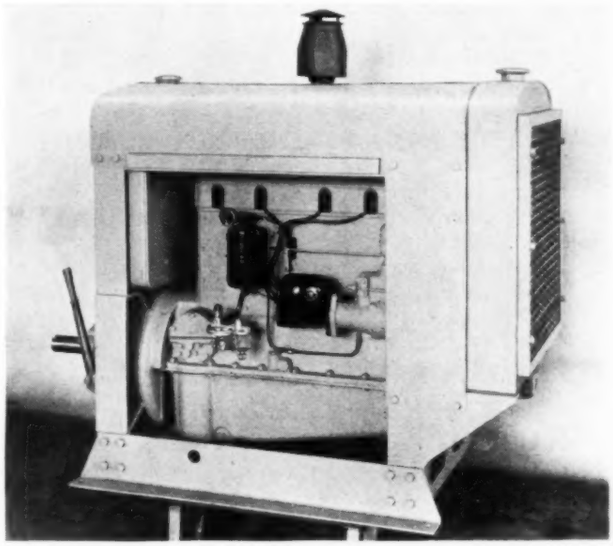
Fig. 26—Sketch illustrating the differential action of the closed-type nozzle. The annular figure (left) indicates the area upon which the injection pressure acts to open the nozzle, while the circle (right) indicates the area upon which the injection pressure acts to hold the valve open. This is a multiple - hole type of nozzle.

It is very much regretted that the remainder of the section on Diesel engines cannot be presented in this issue because of the lack of space but must be carried over into the February issue and it is hoped that the interest will not be lessened thereby. It is proposed: (1) to present a discussion of combustion chambers and to classify and describe briefly the various high-speed Diesel engines that are commonly used in the highway industry; (2) to outline and describe the spark-ignited oil engine; (3) to mention the Diesel engine starting problem and its solution; and (4) to present comparatively the factors involved in fuel costs and other elements to be considered in the selection of power.

NEW ENGINES AND POWER UNITS

Le Roi Exhibits New Series of Three Power Units

There will be placed in production this month a new line of gasoline engines and power units by the LeRoi Company of Milwaukee, Wis. There are three sizes, all of which will be of four cylinders with bores of 4½ by 5, 4½ by 6, and 5 by 6 in. A feature of construction is the wet liner type of cylinder sleeve, and also valve seat inserts, overhead valves, and precision bearings. As regularly furnished, these engines will be built with a 4⅝ to 1 compression ratio which is suitable for using the lower grade of gasoline. For operation on tractor fuels or No. 1 furnace oil, pistons providing a lower compression ratio can be furnished, while they can also be furnished with higher compression ratios for operation on premium gasoline on natural gas. Of course, the lower and higher compression ratios will give a lower and higher power output, respectively. While the engines have been tested up to speeds of about 2200 r.p.m., they are recommended for service at speeds ranging up to 1500 r.p.m. where 40, 48, and 60 hp. are developed by the three sizes, respectively.



Side view of the new LeRoi power unit

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Lauson Offers New ½-Hp. Engine

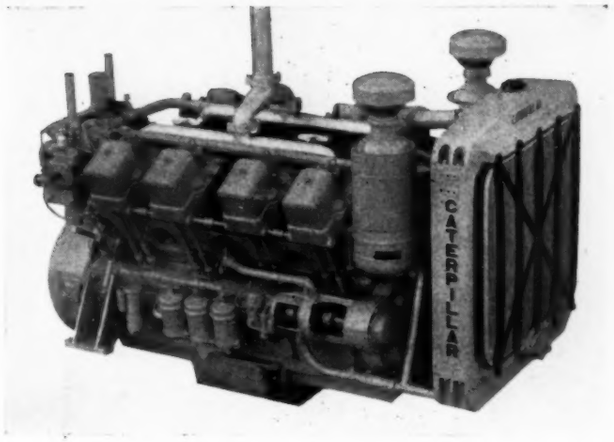
The Lauson Company, New Holstein, Wis., will display at the Road Show a new ½-hp., ball bearing, 4-cycle, air-cooled engine. This little unit is complete with Eisemann magneto, balanced crankshaft, hardened and ground cams. It will operate at a speed of from 1800 to 3600 r.p.m. developing from ½ to ¾ hp. depending upon speed. Connecting rod and piston are of aluminum alloy. Intake and exhaust valves are mechanically operated. The engine is of the L-head design. It is equipped with a flyball governor, maintains a close speed regulation for operating generators and other types of machinery. The total height of the engine is 11 in., while it weighs 26 lb.

▼

A New V-8 Diesel by Caterpillar

The D17000 Diesel power unit, recently announced by Caterpillar Tractor Company of Peoria, Ill., is the outgrowth of a demand for increased power by users of larger engines. It features solid injection of fuel into precombustion chambers. The bore and stroke are 5¾x8-in., and the governed speed is 850 r.p.m. It develops 160 hp. maximum.

The 8 cylinders are in two groups of four, set at an angle of 60 deg. The cylinder heads are easy to remove or replace, being cast separately, while the liners, of heat-treated chrome nickel alloy cast iron, are removable and the blocks are cast in pairs. The gray iron crankcase is heavily ribbed inside, with four large openings on each side to permit easy access to bearings.



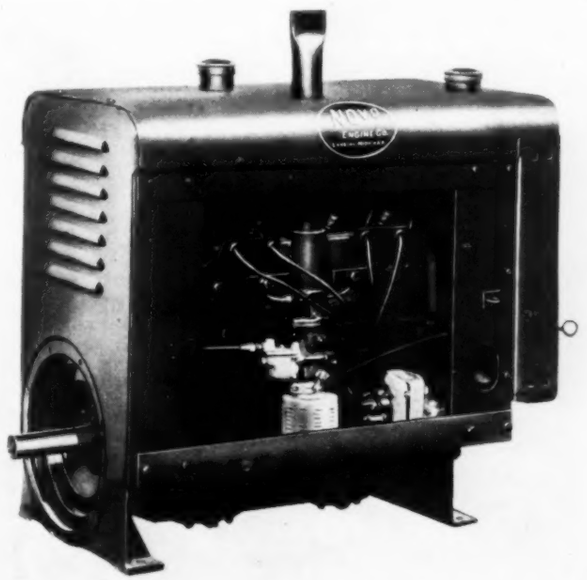
The Caterpillar 8-cylinder V-type Diesel engine

A single row of eight individual fuel pumps is conveniently located between the cylinder banks, and all fuel lines to injectors are the same length. Fuel and lubricating oil filters, air cleaners, manifolding, cooling and thermostatic control are individually supplied for each cylinder bank. Lubrication is of the forced feed type.

▼

New Line of Gasoline Engines Announced by Novo

The Novo Engine Co., Lansing, Mich., have just announced a new series of 2 and 4-cylinder gasoline engines incorporating many modern features of design. There will be two 2-cylinder engines of 2¾ by 4-in. and 3¼ by 4-in. bore and stroke, respectively, and two 4-cylinder engines of the same cylinder dimensions. The line will be known as the "C" line. Cooling is by radiator with thermo-syphon circulation, although water pump circulation may be added. The engine has been designed for industrial application and employs New Departure ball bearings on both the crankshaft and the cam shaft. They may be equipped with battery ignition when electric starter and generator are specified.



Ignition and carburetor side of the Novo 4-cylinder power unit

EDITORIALS

Our 30th Anniversary

IN January, 1906, the first issue of "Engineering-Contracting" was published in New York City by the late Myron C. Clark and Halbert P. Gillette. A few months later it absorbed "Contract News" and became a weekly periodical. Early in 1907, "the panic year," the headquarters of this publishing firm were moved to Chicago. During the depression of that year "Engineering World" was merged with "Engineering-Contracting," and about that time the name was changed to "Engineering and Contracting." Shortly thereafter "The Dirt Mover" was purchased and merged with "Engineering and Contracting."

The early editorial slogan of that periodical was "E & C, a serial sequel to Gillette's Handbook of Cost Data, specializing in articles on methods and cost of construction." The sales of that Handbook had broken all records for book sales in the civil engineering field, and within a few years totaled 50,000 copies. The profits from these sales financed the publication of "Engineering and Contracting" until it became self supporting.

In 1917, it was decided to publish "Engineering and Contracting" as four monthly magazines, each specializing in a branch of the civil engineering field. Subsequent mergers of two pairs of these monthlies resulted in the present two engineering magazines published by Gillette Publishing Co., namely, "Roads and Streets" and "Water Works and Sewerage."

In 1927 the last named magazine absorbed "Municipal Engineering." In 1932 "Roads and Streets" absorbed "Good Roads," which had been established in 1892 by the Late E. L. Powers whose widow, Nan S. Powers, is Publishing Director of Powers' Road and Street Catalog which is published annually by the Gillette Publishing Co. This catalog is also the result of a "merger," two highway catalogs having been brought together in this one.

The idea of effecting mergers of several engineering periodicals was first suggested to the writer by the late H. L. Saunders, who was president of the Ingersoll-Rand Drill Co.

During 1917 and 1918 the late Lewis S. Louer and the late Robert W. Hume purchased the stock of Myron C. Clark's widow, and became "partners" in this publishing enterprise. Both were remarkably able men, worthy successors to M. C. Clark. "M. C.," it should be added, had been the manager of the book department of "Engineering News" for 8 years when he and "H. P.," who had been on the editorial staff of that great paper, decided to become publishers on their own account. Their first publication in 1904 was the book "Rock Excavation Methods and Cost" by Gillette which was soon followed by the "Handbook of Cost Data." In this connection we cannot refrain from quoting two sentences from the prefaces of two books:

"For the data given under Construction Cost we are very largely indebted to Mr. Halbert P. Gillette's monumental 'Cost Data.' "—"Trautwine's Civil Engineer's Pocket-Book" (1918).

"During the past dozen years, chiefly as a result of the writings of such men as H. P. Gillette and F. W. Taylor, interest in the economic side of engineering has greatly widened; so that we now see the word Economics in titles of technical articles, chapters, and even books." —"Engineering Economics" (1915) by Prof. J. C. L. Fish of Stanford University.

It was the stress laid upon engineering economics that characterized the books and periodicals published by this firm from the beginning. No opportunity was lost, whether in editorials or in lectures, to preach the doctrine that unit-costs are the ultimate criteria of relative economy of design, of construction and of operation. Even Tredgold's old definition of engineering had to be revised to show the economic nature of engineering. Tredgold's definition was:

"Engineering is the art of directing the great sources of power in nature for the use and convenience of man."

The definition in the Handbook of Cost Data was:

"Engineering is the conscious application of science to the problems of economic production."

In one phraseology or another this last definition has been adopted by many American engineering societies.

So, in celebrating our 30th anniversary, we feel that we are also celebrating the anniversary of a new and broader conception of engineering. Wellington, it is true, had a similar conception at an earlier date, but to make it the conception of the entire civil engineering profession called for continuous and wide publication such as Wellington had not given to it.

In the chapter on Scientific Management of his new book, "Engineering and Business Economics," Mr. Gillette outlines the history of scientific management and the part played in that history by the publications of the Gillette Publishing Co. It may be news to the younger readers of "Roads and Streets" and "Water Works and Sewerage" to learn that not only the expression "science of management" but the first code of its laws was published in "Cost Analysis Engineering" in 1909 by Gillette and Dana.

Shortly thereafter several editorial attacks were made on the conception of management as being a science. But about a decade later, at a convention of a school of finance for business executives, one of the great executives, Frank A. Vanderlip, President of the National City Bank, of New York, said: "I believe we are a nation of economic illiterates. There is a science of business. It is something teachable."

The existence of scores of books and hundreds of articles published in the last 30 years on scientific management and the principles of business economics bear witness to the soundness of the doctrine that the editors of this periodical began preaching 30 years ago.

STATE HIGHWAY CONSTRUCTION

Reports from Highway Officials Showing Probable Expenditures in 1936

NEW ENGLAND DIVISION

Maine

The State Highway Commission will have in 1936 $1,000,000 for state aid road construction against which the towns will furnish probably from $450,000 to $500,000. It will have $700,000 for the construction of Third Class highways. The mileage is estimated at 250 miles of gravel road and the cost $2,200,000.

Two contracts on the Federal 1935 grade crossing elimination projects have been awarded. These two projects will be carried over to 1936, the expenditure being about $150,000 in 1936 and it is estimated the cost of about 17 other projects will be $1,275,000, making the estimated cost for this work $1,425,000.

An expenditure of about $700,000 is estimated for bridge work for new projects in 1936 and an expenditure of $300,000 for about 25 projects carried over, making its estimated expenditure for this work in 1936 $1,000,000.

An expenditure of $2,800,000 is estimated in 1936 on the 1935 program of Federal aid and WPA projects. This will involve the construction of approximately 81 miles of gravel, 16 miles of bituminous macadam, 13 miles of bituminous concrete, 0.5 mile of cement concrete and 8 roadside improvement projects.

L. D. Barrows, Augusta, Me., is Chief Engineer, State Highway Commission.

▼

New Hampshire

No construction program by types or mileages is available as yet. Total funds available for next year including balance from 1935 will amount to $4,360,000.

F. E. Everett, Concord, N. H., is State Highway Commissioner.

▼

Vermont

The approximate mileage of highway construction carried over from 1935 for completion in 1936 is as follows:

	Miles
Grading, Base and Drainage	7
Gravel Surface	2
Crushed Stone Mixed-in-Place	12
Crushed Gravel Mixed-in-Place	39
Penetration Macadam	6
Concrete Pavement	2

The above mileages are comprised of incomplete National Recovery, Federal Aid and Works Program projects. The work to be done on contracts already let will involve an expenditure of about $1,800,000. If Federal Aid is available for next year about $1,200,000 will be expended on road construction.

H. E. Sargent, Montpelier, Vt., is State Highway Commissioner.

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Rhode Island

The allotment of Works Program Highway and Works Program Grade Crossing Funds to Rhode Island amounted to $989,208 and $699,691, respectively, or a total of $1,688,899. The following program of projects, to be financed with these funds, has been prepared and approved and will be carried out during the 1936 season:

3.05 miles,	Sheet Asphalt on Concrete Base,	3 Projects
1.30 miles,	Bituminous Macadam	2 Projects
7.10 miles,	Reinforced Cement Concrete	3 Projects
9.00 miles,	Surface-treated Gravel	7 Projects
0.70 miles,	Waterbound Macadam Surfac'g.	2 Projects
0.70 miles,	Concrete Sidewalks and Curb.	1 Project
	4 Concrete Slab Bridges	1 Project
	Roadside Development	1 Project

The scheduled program of grade crossing projects involves the construction of four overpasses at grade crossings and the reconstruction and widening of one existing railroad bridge.

One project, carried over into the 1936 season, covers the construction of 1.12 miles of sheet asphalt pavement on concrete base, approximately 55 ft. wide.

H. C. Thierfelder, Providence, R. I., is Acting Chief of the Division of Roads and Bridges of the State Department of Public Works.

▼

Connecticut

The program of the State Highway Department for 1936 calls for an approximate expenditure of $25,000,000, of which $19,500,000 is for construction, $3,300,000 for maintenance and $2,200,000 for other purposes. The sources of this fund are as follows:

Merritt Highway and Portland-Middletown Bridge

Bonds	$7,500,000
Gasoline Tax	8,000,000
Motor Vehicle Fees	4,500,000
Other sources	5,000,000
(Federal funds included—$3,000,000)	

The *following* tabulations summarize the work to be done:

CONTRACTS TO CARRY OVER INTO 1936

TOTAL LENGTHS AND COST BY TYPES

Gravel—Length, 58,116 ft.; cost, $199,312.

W. B. Macadam—121,013 ft.; $847,235.

Bituminous Macadam—8,100 ft.; $57,183.

Bituminous Concrete—2,221 ft.; cost in Bituminous Macadam.

Concrete—11,866 ft.; $152,618.

Five Bridges, 18 Culverts and Highway Grade Separation at a cost of $128,099.65.

CONTRACTS NOT STARTED AS OF DECEMBER 15, 1935

Gravel—Length, 465,660 ft.; cost, *$996,909.

W. B. Macadam—79,679 ft.; $373,009.

Bituminous Macadam—54,304 ft.; $279,719.

Bituminous Concrete—17,144 ft.; $201,124.

Two Bridges and Storm Sewer at a cost of $107,915.55.

John A. MacDonald, Hartford, Conn., is State Highway Commissioner.

*Includes 5 small Bridges.

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EAST NORTH CENTRAL DIVISION

Ohio

It is not possible at this time to give details of the 1936 program of the State Highway Department. It is probable, however, that the department will improve 500 miles of roads, including grading, draining and surfacing and a number of bridges, viaducts and subway contracts. Possibly 300 contracts will be let during 1936, the contracts ranging from $2,500 to $870,000 each.

John Jaster, Jr., Columbus, O., is State Highway Director.

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Indiana

The forecast for state highway work in Indiana for 1936 shows the following:

1. Total amount of money estimated to be available during 1936:
   - (a) Construction $14,739,964
   - (b) Maintenance 3,400,000

   $18,139,964
2. Percentage of increase of estimated expenditures for 1936, over that of 1935.. 6%
3. Sources of revenue from which total under No. 1 will be made available:
   - (a) Regular Federal Aid (Hayden-Cartwright) ..... $ 3,087,613
   - (b) Emergency Federal Relief (NIRA) 1,500,000
   - (c) Works Relief (ERA Act of 1935). 10,052,351
   - (d) State Funds (Gas tax and license fees) 3,500,000

   Total $18,139,964
4. Distribution of estimated expenditures by types:
   - (a) Grading ..... $ 4,723,000
   - (b) Surfacing and resurfacing..... 6,073,000
   - (c) Bridges and grade separations..... 7,343,964

   $18,139,964

M. R. Keefe, Indianapolis, Ind., is Chief Engineer, State Highway Commission.

Illinois

According to present estimates the Illinois Division of Highways' 1936 construction program will consist of about 130 miles of high type paving, 35 miles of bituminous resurfacing, 135 miles of gravel or crushed stone surfacing, 575 miles of grading, and 125 separate bridges. A large portion of the grading mileage consists of secondary road improvements under our U. S. Works program, and on a considerable portion of this the counties intend to add gravel surfacing after the state has completed the grading work. The total estimated cost of the state's 1936 construction is $32,000,000.

The program as outlined includes contracts awarded in 1935 and carried over into 1936 for completion, as well as work which it is expected to award during the coming year. These estimates do not include improvements to be undertaken by the counties and municipalities under state supervision.

Ernst Lieberman, Springfield, Ill., is Chief Highway Engineer.

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Michigan

Probable 1936 expenditures for road construction are $11,000,000 on projects now under contract under the U. S. Works Highway and Grade Crossing Program, $5,500,000 on 1936 Federal-Aid projects now under contract and $7,700,000 on 1937 Federal Aid projects to be placed under contract and constructed this year. Involves 222 miles grading and drainage, 485 miles high type surfaces, 89 miles low type surfaces, 26 grade separations and 24 bridges. In addition to regular construction work the state highway department expects to supervise the expenditure of $6,000,000 of WPA funds for trunk line road betterment and a like amount for the grading and drainage of so-called tourist or resort roads on new locations. We have no state fund program.

Murray D. Van Wagoner, Lansing, Mich., is State Highway Commissioner.

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Wisconsin

The accompanying tabulations show the uncompleted construction carried over in 1936 and the tentative 1936 highway construction program. These figures have been difficult to prepare for the reason that the calendar year and the fiscal year do not coincide and for the further reason that under uncompleted construction carried over into 1936 there is shown some of the 1936 program which was advanced and on which bids were taken and in some instances some work done during the calendar year of 1935.

The figures are, of course, approximate, it being difficult to determine in all instances the exact amount which will be expended for the different types during the coming year.

UNCOMPLETED CONSTRUCTION CARRIED OVER INTO 1936

Type	*Federal* Length	*Federal* Amount	*State* Length	*State* Amount	*Day Labor* Length	*Day Labor* Amount	*Total* Length	*Total* Amount
Concrete	6.5	$ 250,300	1.5	$ 35,700	1.0	$ 17,800	9.0	$ 303,800
Gravel	60.5	330,200	3.5	10,000	13.0	30,500	77.0	370,700
Crushed Stone	9.0	55,100	4.5	9,700	1.0	2,300	14.5	67,100
High Type Bituminous	...	.....	...	.....	...	.....	...	.....
Intermediate Type Bituminous	0 5	2,000	...	.....	...	.....	.05	2,000
Low Type Bituminous	...	.....	...	.....	9.0	33,800	9.0	33,800
Grade and Drain	102.0	1,216,000	3.0	25,600	0.5	1,200	105.5	1,242,800
Structures	...	860,400	...	38,900	...	.....	...	899,300
Miscellaneous	...	3,700	...	.....	...	18,300	...	22,000
Total	178.5	$2,717,700	12.5	$119,900	24.5	$103,900	215.5	$2,941,500

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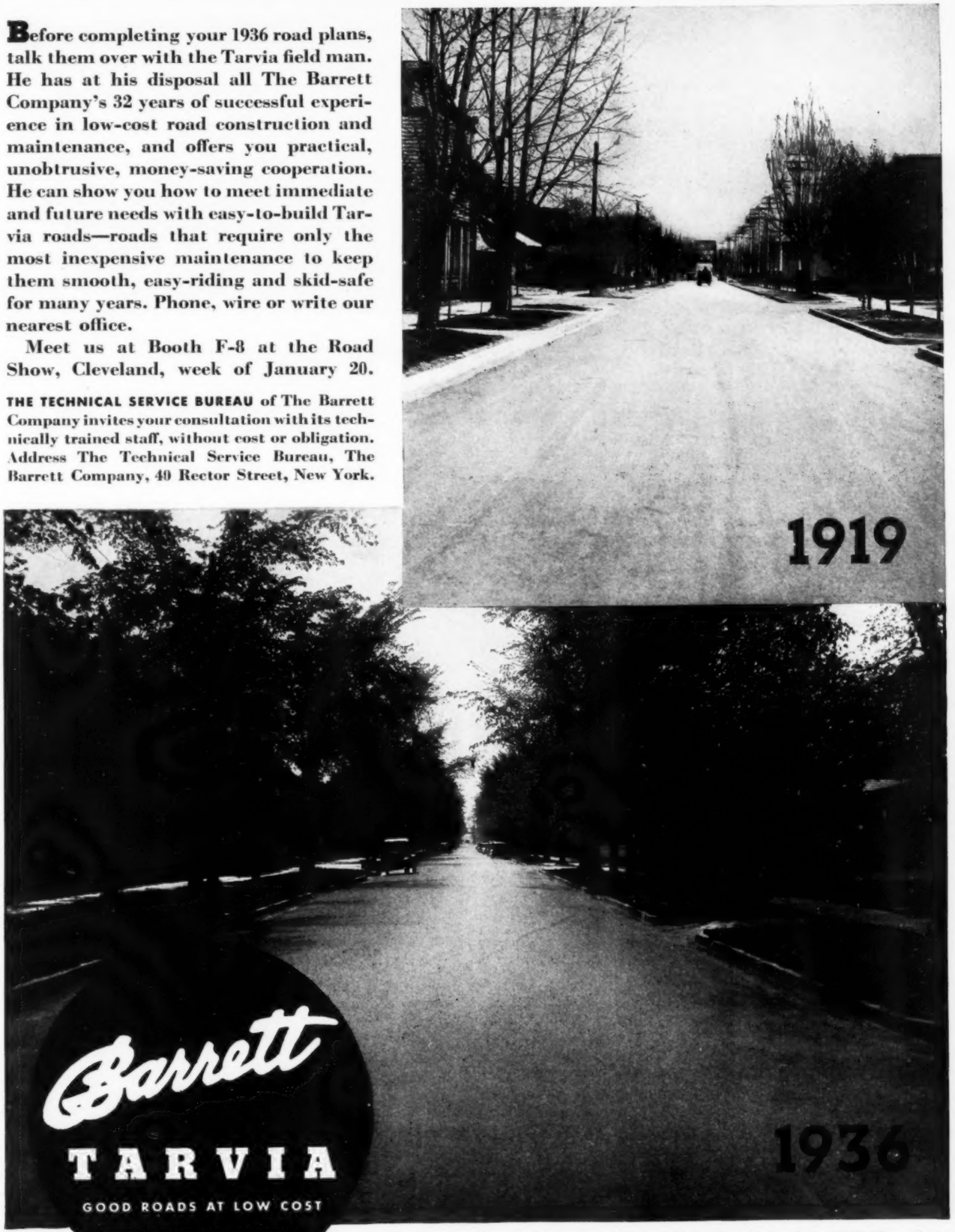
THE TECHNICAL SERVICE BUREAU of The Barrett Company invites your consultation with its technically trained staff, without cost or obligation. Address The Technical Service Bureau, The Barrett Company, 40 Rector Street, New York.



Spruce Street, Sault Ste. Marie, Mich. Tarvia-built in 1919. Top photo shows Spruce Street as it looked the year it was built. Lower photo shows the condition of the road last summer—how it will look in 1936.

THE BARRETT COMPANY New York Chicago Philadelphia Birmingham Boston St. Louis Cleveland Minneapolis Lebanon Milwaukee Detroit Baltimore Columbus Youngstown Toledo Buffalo Providence Syracuse Hartford Cincinnati Bethlehem Rochester Portland, Me. In Canada: THE BARRETT COMPANY, LTD. Montreal Toronto Winnipeg Vancouver

1936 HIGHWAY CONSTRUCTION PROGRAM

	Miles	Amount
High Type Surfacing	95	$ 3,000,000
Low Type Bituminous Surfacing	150	910,000
Gravel or Crushed Stone Surfacing	460	1,500,000
Grade and Drain	380	3,300,000
Structures	..	7,027,000
Miscellaneous	..	200,000
Total		$15,937,000

E. L. Roettiger, Madison, Wis., is State Highway Engineer.

WEST NORTH CENTRAL DIVISION

Minnesota

Following are available estimates on the Minnesota Highway Department's 1936 construction program:

Seven hundred miles gravel or crushed stone surfacing, $2,000,000.

Eleven hundred miles grading, $6,000,000.

One hundred fifty-three miles high type pavement, $4,000,000.

Two hundred fifty six bridges, $6,000,000.

Miscellaneous, $2,000,000.

J. T. Ellison, St. Paul, Minn., is Chief Engineer, State Highway Department.

Iowa

Without making any allowance for the 1937 Federal Aid program, appropriation for which has been authorized by the Hayden-Cartwright Act but has not actually been made, the program of the State Highway Commission is as follows:

Pavement in prospect — 59.7 miles; estimated cost, $2,237,000.

Pavement under construction, carried over into 1936 —87 miles.

Bituminous surfacing work, proposed for next year's construction—256 miles; estimated cost, $949,000. Carried over from 1935, none.

Gravel surfacing work, for 1936 construction—299.2 miles; estimated cost, $582,000. Carried over from 1935, 104 miles.

Grading work, together with bridge and culvert work incidental thereto—Proposed for 1936 construction—388 miles; estimated cost, $3,196,000. Carried over from 1935, 46 miles.

Railway Grade Crossing Program—Overhead crossing structures, 67; estimated cost, $1,916,000. Structures carried over from 1935, 19. Subways proposed for 1936 construction, 15; estimated cost, $595,000. Carried over from 1935 program, none.

The grading and surfacing of approaches to subways has been included in the figures heretofore given for mileages and estimated cost of the various classifications of work.

If Congress makes the 1937 Federal Aid Appropriation available, the figures herein given will be increased by whatever amount of work the State is able to undertake with its 1937 Federal Aid funds.

Fred R. White, Ames, Ia., is Chief Engineer, State Highway Commission.

Missouri

A brief outline of the present outlook for next year's state highway program follows:

There will be available for next year's work approximately $21,000,000. This is an increase of about $4,000,000 over the funds available for 1935.

Of this amount, $6,000,000 is the greater part of the State's allocation of funds under the Works Progress Administration for grade crossing projects. Most of this money will be spent on the major system for high type improvements, a large percentage of which will be in the metropolitan areas.

There are remaining approximately $2,500,000 of the Works Progress Administration Funds allocated for highway projects.

Approximately $2,500,000 will be available for construction out of the revenue from the gasoline tax and vehicle license fees.

The sum of $5,500,000 will be available from regular federal aid under the Hayden-Cartwright Act—$1,600,000 left over from the allotment available July 1, 1935, and the remainder will be available after July 1, 1936.

Approximately $4,500,000 will be spent for maintenance.

A large portion of the available funds other than those specifically marked for grade crossing projects will be spent on improving supplementary roads ar feeder roads to the state highway system. The regular federal aid funds, of course, will have to be spent o· routes that have been made a part of the federal aid highway system. The major portion of the remaining funds will be applied to the construction of, relatively speaking, low cost roads.

T. H. Cutler, Jefferson City, Mo., is Chief Engineer, State Highway Department.

North Dakota

The following is an outline of 1936 program of the State Highway Department:

(Programmed, but not let)

Type	No. of Projects	Miles	Estimated Cost
Grade	59	336	$1,596,000
Gravel	92	517	1,181,000
Bituminous Surfacing	32	122	819,000
Overhead	28		1,960,000
Underpass	13		1,017,000
Crossing Protection	3		17,000
Landscape	7		45,000
Planning Projects	2		91,000

	Uncompleted Projects		Construction Cost
Grade	21	113	
Gravel	13	87	
Bituminous Surfacing	18	69	
Overhead	2		
Landscape	3		
			$1,314,010

The above are approximately 30% complete.

H. C. Frahm, Bismarck, N. Dak., is Chief Engineer, State Highway Department.

South Dakota

The construction program for 1936 calls for 20 miles paving, 200 miles bituminous surfacing, 300 miles gravel surfacing and base courses, 370 miles grading. Total estimated cost is $4,800,000. In addition $2,000,000 will be spent for grade separation structures.

Nebraska

Probable expenditures for 1936 state road construction, including state and federal funds total $8,450,000.

A. T. Lobdell, Omaha, Neb., is Chief Bureau of Roads and Bridges.

(*Continued on page* 85)

Kansas

The 1936 program of the State Highway Commission had not been completed at this writing, so only approximate figures as to the types and mileages can be given. However, the total amount of money available for construction in Kansas in 1936 will be about $18,829,000. This money will be made available from the following sources and in the approximate amounts as given:

Federal Aid (Hayden-Cartwright)	$ 3,300,000
Emergency Relief Program (Flood Relief)	300,000
Works Relief Bill	10,241,000
Public Works Loan and Grant	1,388,000
State Funds	7,700,000

The program as outlined at this time will distribute these funds over various types of construction as follows:

Grading and culverts, 488 miles at an estimated cost of $6,300,000.

Light type surfacing (sand gravel or crushed stone), 428 miles at an estimated cost of $650,000.

Bituminous mat, 476 miles at a cost of $2,497,000.

High type pavement, including both rural and city streets, 85 miles at $3,800,000.

One hundred forty-seven bridges at an estimated cost of $6,082,000.

In addition to the above, $1,100,000 will be spent for light type resurfacing, and $3,000,000 for maintenance.

The total for the three items is as follows:

Construction	$18,829,000
Maintenance	3,000,000
Resurfacing Light Type Roads	1,100,000
Total	$22,929,000

The above total is an increase of about 75 per cent over the expenditures in 1935.

Most of the 1935 projects were completed and the carry-over into the 1936 program will be relatively small.

H. D. Barnes, Topeka, Kan., is State Highway Engineer.

SOUTH ATLANTIC DIVISION

Delaware

During the calendar year 1936 the State Highway Department will make two grade crossing eliminations, concrete overhead, costing $400,000; two grading projects, 5.7 miles, estimated cost $100,500; six concrete paving projects, 5.3 miles, $895,000; five bituminous concrete projects, 3.8 miles, $302,500; fifteen traffic bound projects, 48.7 miles, $207,000; one soil stabilization project, 4.4 miles, $17,000; three bridge projects, reinforced concrete, $100,000. Carried over from 1935 is one grade crossing elimination project, reinforced concrete, $70,000.

W. W. Mack, Dover, Del., is Chief Engineer, State Highway Department.

Maryland

The Maryland State Roads Commission has programmed constructions work for 1936 as follows:

Type of Improvement	No. of Projects	Miles	Estimated Cost
Concrete	14	93.94	$5,700,000
Macadam	18	32.25	450,000
Gravel	10	21.29	225,000
Stabilized Earth	3	4.30	35,000
Sheet Asphalt-Conc. Base	1	0.69	125,000
Conc. Sho. & Bitum. Resurf	1	1.92	135,000
Landscaping	4	38.20	40,000
Bridges	2	.....	375,000
Overhead-RR-GradeXing Elim.	8	.....	1,450,000
Underpass-RR-GradeXing Elim.	3	.....	400,000
Underpass-RR-GradeXing Recon.	2	.....	100,000
Flashing Lights	5	.....	15,000
Crossing Gates	2	.....	20,000
Total			$9,070,000

This does not represent all of the work that will be constructed, but includes that which is programmed at this time.

The following work now under construction is uncompleted, and will be carried over to 1936:

Type of Improvement	No. of Project	Miles	Estimated Cost
Grading & Drainage	1	4.15	$ 29,527
Concrete	2	5.40	310,070
Macadam	7	12.50	148,538
Gravel	1	2.30	20,000
Bridges	2	.....	185,393
Total			$ 693,528

Nathan L. Smith, Baltimore, Md., is Chief Engineer State Roads Commission.

West Virginia

The following statement shows the projects under Federal funds programmed and expected to be let to constract during 1936:

No. of Proj.	Type of Improvement	Miles	Cost
18	Grade and drain	73	$1,468,000
13	Grade, drain and surface tr. base	49	867,000
14	Grade, drain and concrete pave.	30	1,236,000
6	Stone base and surface treatment	25	290,000
7	Concrete paving	11	385,000
5	Bituminous surfacing	22	215,000
10	Bridges		416,000
2	Roadside development		32,120
2	Highway planning		80,849
	TOTAL		$4,989,969
21	Grade elimination projects		$1,876,129
	Balance to be allocated for grade elimination projects (approximately 15 projects)		801,807
			$2,677,937
	GRAND TOTAL		$7,667,906

Construction projects now under contract that will be carried over and completed during 1936 are as follows:

No. of Proj.	Type	Length, Miles	Cost
13	Grade and drain	53.78	$ 923,836
10	Grade, drain and stone base	44.28	891,894
11	Stone base, surface treatment	69.59	889,986
7	Concrete paving	8.84	488,478
8	Bituminous macadam surfac'g	64.40	239,500
2	Guard rail		35,227
1	Slip removal		29,292
14	Bridges		417,701
	TOTAL		$3,915,916

It is not possible at this time to give the 1936 construction program with state funds.

Mortimer W. Smith, Charleston, W. Va., is Chief Engineer, State Highway Commission.

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North Carolina

Probable expenditures for road construction during 1936 amount to $14,200,000. The work includes 47 miles grading, 173 miles topsoil, sand-clay or gravel, 74 miles traffic bound macadam, 389 miles bituminous surface treatment, 60 miles concrete pavement, 96 miles roadside improvement, 89 miles asphalt pavement, 36 miles concrete widening, 66 grade crossing separation projects and 128 electric signals for grade crossings.

W. Vance Baise is State Highway Engineer.

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Florida

The annual budget of the State Road Department is adopted in March and the Federal programs are based on the fiscal year, or extend from July 1st of one year to July 1st of the following year. In consequence of these factors it is extremely difficult to estimate construction miles and types in an ensuing year, since such an estimate would have to be based partly on an annual budget not yet prepared and partly on two or more Federal programs of which at least one is not yet in existence.

Federal funds for 1936 construction, as already provided for under existing Federal programs, will amount to approximately $6,728,081, of which amount $1,874,171 will be applied to grading, $2,548,803 to paving of various types, $1,897,000 to grade separations and approaches and $408,106 to other bridges. These funds are to be divided among 14 grading projects, 33 paving projects, 24 grade separation and approach projects and three other bridge projects.

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EAST SOUTH CENTRAL DIVISION

Kentucky

The estimated expenditures for new construction work in 1936 are approximately $4,900,000. This amount includes only available balances of Works Program Highway and Grade Crossing funds, National Recovery funds, Federal aid funds, and State funds necessary to match remainder 1936 Federal Aid appropriation. It does not include 1937 Federal Aid which if available will amount to approximately $2,300,000. Impossible to estimate amount available for construction with State funds until the legislature now in session determines appropriations for State Highway Department.

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Tennessee

The 1936 construction program calls for 100 miles paving and 150 miles of grading and drainage with $5,000,000 Federal funds. In addition $4,000,000 of Federal funds will be used for grade crossing elimination. No state fund program will be had.

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WEST SOUTH CENTRAL DIVISION

Arkansas

Under the proyisions of the Works Progress Administration Appropriation made available by the last Congress, the State of Arkansas was allocated approximately $3,500,000 for grade separation and protection projects and $3,400,000 for highway construction. Of this total amount, approximately 30 per cent has been placed under contract, an additional 40 per cent is ready for advertisement and receipt of proposals and plans for the remaining 30 per cent are in an advanced stage of completion. It is anticipated that practically all funds will be placed under contract during the 60 to 90 day period immediately following Jan. 1, 1936.

A resume of the program initiated under the terms of the Works Progress Administration Appropriation follows:

28	Grade Crossing Protection Installations (Signals, Flashing Lights, Other Types)	$ 140,000
34	Structures (Overpasses or Underpasses)	2,432,000
14	Bridges	529,000
316	Miles Grading, Minor Drainage Structures, Gravel Surf	2,200,000
144	Miles Bituminous Surfacing	1,500,000
5	Miles Portland Cement Concrete Pavement	124,000
	Total Estimated Cost	$6,925,000

W. W. Zass, Little Rock, Ark., is Chief Engineer State Highway Commission.

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Oklahoma

The following is an estimate of the 1936 program of the State Highway Commission:

State Appropriations

WPH Projects	$ 4,580,670
WP Grade Crossing Projects	5,004,711
Regular Fed. Aid Projects	2,947,521
State Aid Projects	2,661,462
Total	$15,194,364

The above items cover all of the State's appropriation for construction on highways except maintenance funds which are estimated to be approximately $4,000,000 and the sum of approximately $600,000 for engineering, right-of-way, etc. The above appropriations do not include the sum of $850,000 remaining to be spent from last year's National Recovery Appropriation and this amount should be added to the total of $15,194,364.

The total to be spent covers 27 National Recovery Projects, 150 Works Program Highway Projects, 138 Works Program Grade Crossing Projects, 60 of the latter to be for protection at crossing by signals, etc.

The balance of the work which is highway construction, will consist of approximately 650 miles of grading, drainage, gravel surfacing, bridges and a considerable mileage of paving.

Vann T. Moon, Oklahoma City, Okla., is State Highway Engineer.

▼

Texas

The construction program of the state highway department for 1936 has not yet been completed. The estimated regular Federal Aid program includes 200 miles grading and drainage structures at $2,400,000; 700 miles surfacing at $12,000,000; bridges, $1,000,000; landscaping $160,000. Information on state program is not available at this time.

Gibb Gilchrist, Austin, Tex., is State Highway Engineer.

MOUNTAIN DIVISION

Montana

Probable expenditure in 1936 will amount to about $10,000,000.

D. A. McKinnon, Helena, Mont., is State Highway Engineer.

▼

Idaho

The state highway program of Idaho is summarized as follows:

Holdover Projects Let But Not Completed Dec. 31, 1935

	Projects	Miles	Amount
Grading	8	50.4	$ 575,776
Surfacing	2	10.4	139,998
Grading and Surfacing	12	73.3	750,410
Oiling	3	46.0	510,836
Grading, Surfacing and Oiling	1	17.8	144,871
Bridges	6	....	322,887
Grade Separation Structures	14	....	956,817
Culvert	1	....	3,171
Grading and Paving	1	1.2	84,086
Total Holdover	47	199.1	$3,488,852

Summary Idaho 1936 State Highway Program

	Projects	Miles	Amount
Grading	4	22.2	$ 342,000
Grading and Surfacing	22	121.8	1,341,000
Oiling	1	13.0	160,000
Bridges	5	....	310,000
Grade Separation Structures	9	....	826,000
Roadside Beautification	1	....	22,000
Protective Crossing Devices	20	....	44,000
Reconstruction	1	0.3	15,000
Rip Rap	1	....	75,000
Total Program for 1936	64	157.3	$3,135,000

Additional Available July 1, 1936

Anticipated Regular Federal Aid	$1,531,162
State Matching Funds	1,023,640
	$2,554,802

J. H. Stemmer, Boise, Idaho, is State Highway Director.

▼

Wyoming

The 1936 program will consist of approximately 200 miles bituminous road mix, 130 miles gravel surfacing and 70 miles new grading involving expenditure of $1,500,000 regular Federal aid and $1,000,000 state funds.

James B. True, Cheyenne, Wyo., is State Highway Engineer.

▲

Colorado

The following is a resume of the State Highway Department work in 1935. It is not possible at this time to give information regarding the appropriations for 1936.

There were 41 projects carried over from 1934 and finished during 1935; of these 35 projects were gravel surfacing with a length of 198 miles, completed at a cost of $1,837,300.

There were two paving projects 5.183 miles long, costing $121,364.

One grading project 2.72 miles long, costing $22,750.

Three roadside landscaping projects, costing $16,425.

During 1936 there were 43 projects started and completed under jurisdiction of the Engineering Department and 39 light oiling projects completed by the forces of the Maintenance Department. This oiling consisted of placing 1 in. to 1½ in. mat.

This group covered three grading projects 8.609 miles long, costing $220,000.

Twenty-seven gravel surfacing projects, 69.305 miles long, costing $1,300,000.

Forty-one oiling projects, including the maintenance projects, having a length of 46 miles, costing $500,000.

One asphalt pavement project, 1,217 miles long, cost ing $52,000.

Five bridge projects 0.175 miles long, costing $100,000.

Five landscaping projects costing $20,000.

Another group of projects has been started but will not be completed until 1936. These include:

Seven bridge and approach projects 1.841 miles long costing $500,000.

Fifteen gravel surfacing projects 92.926 miles long, costing $1,500,000.

One concrete paving project costing $20,000.

Two landscaping projects costing $5,000.

In a number of cases there are many major structures that are not listed separately. In all of the abovementioned groups there are 120 structures of this class.

As will be noted from the number of projects and cost of the work, there were not any outstanding large contracts during the year, but the work consisted rather of many smaller jobs well scattered over the state. Probably the largest contract was 75 miles of heavy grading in Mineral County on the east side of Wolf Creek Pass. A gravel surfacing project in Pueblo County, extending a little under 16 miles between Pueblo and Florence, was also one of the large contracts.

Chas. D. Vail, Denver, Colo., is State Highway Engineer.

▼

Arizona

The proposed program of the State Highway Department for the fiscal year 1935-1936 (July 1, 1935-June 30, 1936) calls for a total expenditure of $8,682,958, obtained as follows:

WPH Funds	$1,139,000
WPSS Funds	863,000
WPSO Funds	642,460
WPMH Funds	643,000
WPMS Funds	4,000
Regular F. A. Funds	2,254,498
Grade Separation Funds	1,443,000
Maintenance Funds	1,087,000
Betterment Funds	207,000
NRA Funds*	* 400,000
Grand Total	$8,682,958

*Carry-over Projects under 1934-5 NRA Funds.

The construction projects by WPA Funds are as follows:

	No. Projects	Mileage
Concrete	1	6.3
Asphalt	1	1.6
Oil Process	10	77.4
Gravel Surface	9	....
Grade and Drain	18	112.54

Of the above projects, the concrete is under construc-

tion; 4 of the oil process projects are under construction, and 8 of the grading and drainage projects.

The detailed list of construction projects under regular Federal Aid funds follows:

DETAIL LIST OF CONSTRUCTION PROJECTS UNDER REGULAR F. A. FUNDS, 1935-36

F. A. No.	Oil Process	Gravel Surface	Amount	Remarks	Pct. Comp.
83-D	16.8	...	$218,294	UC	.06
78-G	...	5.5	125,000	UC	.01
79-I Sch 2	0.1	...	11,443	UC Widening	.47
79-I Sch 1	0.8	...	32,943	UC Widening	.10
79-H & 11	10.0	...	107,000	Programmed Widening	..
80-I	...	10.8	172,747	UC	.06
95-F	...	11.2	173,700	UC	.60
95-H	...	8.6	169,288	UC	.48
89-B	...	...	12,654	Programmed BTF	..
99-H	...	6.4	249,675	UC	.13
99-J	...	...	240,002	UC	.17
43	...	.3	15,705	UC	.95
8-A	.5	...	29,616	UC	.78
47	...	...	10,477	UC Widening	.27
80-G	23.6	...	108,788	UC	.20
20	.6	...	37,982	UC	.12
22	.02	...	1,250	UC	.12
105-D	...	...	260,000	Programmed	..
29	(1.6)	...	52,465	UC Widening PVT	.39
94-D	...	...	7,030	Beautification	..
97-B	...	...	5,362	Beautification	..
96-C	...	6.4	135,500	Programmed	..
55 Reo	...	1.2	40,000	UC	..
	Survey, Plans, etc.,		37,570		

UC—Under Construction.

In addition to the above are .01 mile asphalt and two grading and drainage projects of a total length of 20½ miles.

Included in the program are 12 grade separation projects, one which is under construction.

Utah

It is estimated that the State Road Commission will have approximately $7,675,000 available for highways in 1936. This is an increase of 25 per cent over the 1935 expenditures. The above total is to be spent as follows:

Construction	$6,000,000
Maintenance	1,200,000
Other	475,000
Total	$7,675,000

The sources of the highway fund are as follows:

Federal Aid (Hayden Cartwright)	$1,676,102
Works Relief Bill	3,297,917
State Gas Tax	2,600,000
Vehicle License Fees and Other	100,980

The amount of construction that will be undertaken includes the following:

	Miles	Amount	Yards
Grading	180	$1,240,000	2,500,000
	Miles	Amount	Tons
Gravel or crushed stone surfacing	100	700,000	900,000
Oil Treatment	100	400,000	.....
Paving, High Type	30	1,800,000	.....
Paving, Low Type	30	360,000	.....
Bridges	No. 35	1,500,000	.....

K. C. Wright, Salt Lake City, Utah, is Chief Engineer, State Road Commission.

Nevada

The highway, bridge and grade crossing program of the State Highway Department for the fiscal year 1936 follows:

WORKS PROGRAM GRADE CROSSING PROJECTS

Projects on Federal Aid System Outside Municipalities and Metropolitan Areas

ROADSIDE BEAUTIFICATION

County	Location	Length in miles	Total est. cost
Washoe	Reno to Purdy	14.72	$17,300
	Vista to Hafed	5.25	7,000
	Hafed to Clark	8.32	10,000
Ormsby	Lakeview to Carson City	3.44	4,000
	Moundhouse to Carson City	5.66	5,000

RETAINING WALL

Washoe	Reno to Lawton	0.16	47,000
	West State line to two miles east of Verdi	0.10	30,000

GRADE ONLY

Washoe-Storey	Geiger Grade	7.45	299,000

LINE SHIFT WIDENING

Mineral	Walker Lake—Dutch Creek to ten miles east	0.50	25,000

GRADE AND GRAVEL

Elko	Realignment to connect with Wells Overpass	0.75	20,000

Secondary Projects Outside Municipalities and Metropolitan Areas and Not Included in the State or Federal Aid Systems, First Classification Secondaries

GRADE AND GRAVEL

County	Location	Length in miles	Total est. cost
Pershing	Lovelock to five miles south	5.00	$60,000
Douglas	Gardnerville to Centerville	3.90	80,000
Churchill	Fallon north to Old River section	7.00	100,000
Washoe	Peckham Lane	2.00	20,000

GRADE, GRAVEL AND BRIDGE

Douglas	Junction of State route to Genoa	3.67	90,000
Churchill	Fallon to Stillwater	9.40	154,128

Projects Within Municipalities and Metropolitan Areas

GRADE, GRAVEL, CURBS AND GUTTERS

Lyon	City of Yerington	0.90	$47,000
Humboldt	City of Winnemucca	0.04	15,000
Clark	City of Las Vegas	1.00	50,000
	City of Las Vegas	1.50	50,000
White Pine	City of Ely	0.80	50,000

ROADSIDE BEAUTIFICATION, AND GRADE AND GRAVEL

Ormsby	Carson City to Lone Mountain Cemetery	0.40	10,000

GRADE AND GRAVEL

Ormsby	Carson City to State Prison	1.52	25,000
Washoe	Boeing Airport Road	1.50	20,000
	Sparks to junction with Pyramid Lake road	2.00	25,000

GRADE, CURBS AND GUTTERS, OIL SURFACE

Washoe	North Reno city limits	0.50	10,000

GRADE, GRAVEL, OIL

Ormsby	Carson City, one block on Mountain Street	0.07	2,000
Pershing	City of Lovelock, Dartmouth Avenue	0.75	15,000

BRIDGE OVER HUMBOLDT RIVER AND APPROACHES

Elko	City of Elko	1.00	45,000

BRIDGE OVER TRUCKEE RIVER

Washoe	Lake Street to City of Reno		48,000
Washoe	Sierra Street in City of Reno		48,000

PAVE AND CONSTRUCT CURBS AND GUTTERS

Washoe	City of Reno	2.40	104,000

Projects Outside Municipalities and Metropolitan Areas, But Not Included in Federal Aid System, Second Classification Secondaries

GRADE AND GRAVEL

County	Location	Length in miles	Total est. cost
Nye	Tonopah to three miles east	3.00	$57,000
Storey-Lyon	Silver City to Virginia City	5.20	160,000
White Pine	Preston to Lund	5.38	80,000
Clark	Railroad Pass toward Searchlight	10.00	100,000
Elko	Fifteen miles north of Elko to Dinner station	8.16	120,000
Esmeralda	Silver Peak to Blair Junction	20.00	100,000
White Pine	East of Fort Connors Pass toward Baker	10.00	60,000
State-Wide Planning Survey			33,646
Total Works Program Highway Projects			$2,243,074

WORKS PROGRAM GRADE CROSSING PROJECTS

Projects on Federal Aid System Outside Municipalities

OVERHEAD GRADE SEPARATION

County	*Location*	*Total estimated cost*
Elko	Western Pacific Railroad at Wendover	$ 57,804
	Western Pacific Railroad at Deeth	62,538
Eureka	Western Pacific Railroad at Dunphy	99,416

UNDERPASS GRADE SEPARATION

Lyon	Southern Pacific Railroad at Fernley	40,669

Projects Within Municipalities on Federal Aid System

UNDERPASS GRADE SEPARATION

Humboldt	Southern Pacific Railroad at Winnemucca	$ 45,667

OVERPASS GRADE SEPARATION

Humboldt	Western Pacific Railroad at Winnemucca	150,000

WIG-WAG SAFETY DEVICE

White Pine	Nevada Northern Railway in Ely	2,500
	Nevada Northern Railway in East Ely	2,500

Projects Within Municipalities Not on Federal Aid System

UNDERPASS GRADE SEPARATION

Clark	Los Angeles and Salt Lake Railroad in Las Vegas	$150,000

Projects Within Municipalities Not on Federal Aid or State Highway System

UNDERPASS GRADE SEPARATION

Washoe	Southern Pacific Railroad in Reno	$152,855

Projects Within Metropolitan Areas But Not on Federal Aid or State Highway System

UNDERPASS GRADE SEPARATION

Washoe	Southern Pacific Railroad on 2nd St. in Reno	$110,000
State-Wide Planning Survey		13,308
Total Grade Crossing Program		$887,260

Robert A. Allen, Carson City, Nev., is State Highway Engineer.

PACIFIC DIVISION

Washington

About 50 per cent of the Federal allotment, amounting to $6,121,000, to carry out the U. S. Works Program Highway and Grade Crossing Projects under the Emergency Relief Appropriation Act of 1935 has been placed under contract as of Jan. 1, 1936. The remainder of this program will be let during the current year. About 70 per cent of the Federal Aid and State Program for the year 1935 was placed under contract prior to Jan. 1, 1936, and the remaining 30 per cent will be let this year.

The actual expenditures during the year 1935 from State and Federal funds for all highway purposes, under the control of the department, including overhead, maintenance and construction amounted to $10,700,000.

The following is a brief summary of the number of miles of each type of construction placed under contract during the year 1935:

Miles by Types of Contracts Awarded—1935

257	Miles	Grading and Surfacing
41	"	Cement Concrete Pavement
5	"	Asphaltic Concrete Pavement
64	"	Heavy Oiled Surface
195	"	Bituminous Retread Surface
492	"	Bituminous Surface Treatment
4	"	Bridges.

The value of the uncompleted work carried over from 1935 into 1936 is $6,350.

The details for the additional construction program to be undertaken during the year 1936 from revenues to be derived during the coming fiscal year beginning April 1, 1936, are not yet available. However, the following is a brief summary of the estimated revenue which will be available to this department for highway purposes, during the next fiscal year beginning April 1, 1936:

(a) Federal Aid Construction $1,900,000
(b) State Funds:
(1) Maintenance $2,500,000
(2) Construction, Overhead and Maintenance 3,500,000
Total $6,000,000

The new construction program for the coming fiscal year will consist of approximately the following percentages of the various types of construction:

Grading and Surfacing with crushed stone	32 per cent
Bituminous Surface Treatments	20 per cent
Cement Concrete and Asphaltic Concrete Pavement	15 per cent
Bridges and Structures	33 per cent

L. V. Murrow, Olympia, Wash., is State Director of Highways.

Oregon

Expenditures for state highway construction in Oregon during the calendar year 1935 have amounted to approximately $8,300,000. The Federal Government has contributed $4,100,000 and the State $4,200,000. These amounts include $3,500,000 expended in connection with the construction of the five Oregon Coast Highway Bridges, PWA contracts, but do not include forest highway activities under the supervision of the U. S. Bureau of Public Roads.

The following approximate mileages of construction work were accomplished during the year 1935:

Cement concrete paving	10 miles
Bituminous macadam paving	24 miles
Oil surfacing	35 miles
Crushed rock or gravel surfacing	90 miles
Grading and grade widening	75 miles
Bridges completed (number)	22

There were 54 contracts awarded in the fall of 1935 out of the 1936 highway construction program. In value, these contracts amounted to approximately one-half of the total of $9,100,000 available in the program. The remaining projects are scheduled for letting early in the new year. The completing of the Coast bridges will require further expenditures of $1,600,000 in 1936.

The approximated mileages of highway improvement involved in the 1936 program are as follows:

Cement concrete paving	30 miles
Bituminous macadam paving	20 miles
Oil surfacing	180 miles
Crushed rock or gravel surfacing	190 miles
Grading and grade widening	220 miles
Grade separation structures (number)	20
Bridges (number)	40

R. H. Baldock, Salem, Ore., is State Highway Engineer.

California

Seventeen and one-half million dollars in major projects remain from California state budget and regular Federal Aid for period of next 18 months. Five and one-half million dollars remain for both Works Program highway and grade crossing projects. For year 1935 more than $23,000,000 major construction projects put under way in following amounts: $5,860,000 WP grade separations, $3,790,000 WP highway projects, $4,000,000 current biennium projects financed by state and regular Federal Aid, $9,400,000 previous biennium and miscellaneous funds. The 1935 construction mileage was 109 miles pavement, 236 bituminous crushed rock, 25 untreated rock, 80 graded road bed, 1,360 oil road bed and shoulders, 78 bridges and grade separations.

C. H. Purcell, Sacramento, Calif., is State Highway Engineer.

BAY CITY *design features mean* MORE YARDAGE

● Sturdy, tough and dependable, yet never extreme, Bay City design offers economy of operation and upkeep. Note for instance, the machinery assembly illustrated at the left. Tandem drums with more cable surface permits straight cable lead from drums with any boom or bucket, thus avoiding undue cable wear without off-center pull. Helical cut alloy steel gears insure quiet, smooth operation and longer life. This efficient machinery arrangement and design is standard on all Bay City full-revolving models.

Before you buy your next shovel, compare Bay City construction materials, design, accessibility, speed, working ranges and safe load capacity with any machine in the same capacity or weight class. You can't beat Bay City value regardless of what you pay. Convertible Bay City equipment, with standardized design, incorporates the best construction features, eliminating surplus dead weight, thus adding to productive yardage and effecting lower costs.

• • •

first public showing

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Cleveland, Jan. 20-24, 1936

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A 10-ton machine that can really "take it." All modern features of design and unit castings. Strength and sturdiness not sacrificed for light weight or price.

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Model 62 — one yard Diesel shovel

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20—Safety worm boom hoist.
21—Separate hoist drums.
22—Internal swing teeth.
23—Unequalled steering at full speed.
24—Convertible—without machinery change.
25—Accessibility for inspection or adjustment.

BAY CITY SHOVELS Inc. (Eastern Offices, Roselle, N. J.) **BAY CITY, MICH.**

EQUIPMENT AND MATERIALS ON DISPLAY AT THE 1936 ROAD SHOW

In the following pages ROADS & STREETS presents its preview of the exhibits to be shown at the Road Show at Cleveland, Jan. 20-24. All the exhibits are described regarding which information was available up to the time of going to press.

Adams to Show New Graders

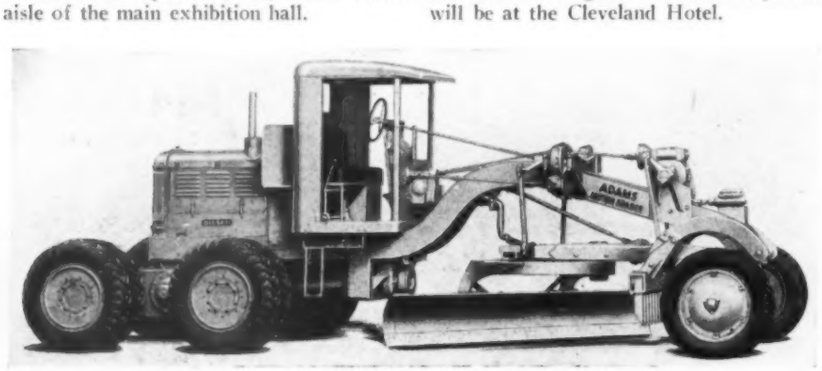
The J. D. Adams Co., Indianapolis, Ind., will present to the public view for the first time what are known as Adams heavy-duty motor graders, Nos. 50 and 51. These new machines are identical, excepting the power units—No. 50 is powered by an International six-cylinder gasoline engine, developing 59 H.P., and Model 51 (illustrated here) is powered by the International diesel engine, developing 57 H.P.

The frame and drawbar design is the all-welded, box-type construction, recently introduced in the new-type Adams leaning wheel graders. As in the case of the leaning wheel graders, the manufacturer claims that this construction not only affords extraordinary strength and rigidity, but greatly improves visibility of the blade and permits a wider range of blade adjustments than is possible with any other design.

The new machines have five forward speeds, each of which is variable by a governor control, so that practically any speed can be obtained from 1 to 15 miles per hour. This extreme flexibility permits operating the machine at the proper speed for any job, from slow, difficult scarifying, to high-speed maintenance. Either machine may be had with 12, 14 or 16 ft. blade, with or without scarifier, and with dual-tired, two-wheel drive on the rear, or tandem drive, with four or eight-drive wheels.

The new-type Adams Leaning Wheel Graders will be represented in the Adams exhibit and a complete demonstration of these machines will be made to show the extraordinary blade positions obtainable. The new Adams gasoline-engine-driven arc welder for shop and field use will also be on display.

The Adams space is D-15, on the center aisle of the main exhibition hall.



New Adams Grader, Model 51

Air Reduction Sales Co. to Demonstrate Welding Operations

The exhibit of the Air Reduction Sales Co., New York, will include Airco oxygen, Airco acetylene, Airco-DB welding and cutting apparatus and supplies, National Carbide, National Carbide lights, Wilson electric arc welding machines and electrodes, and Stoody hard-facing rods. Practical demonstrations of Oxyacetylene and Electric welding will be conducted throughout the entire show. Electric arc welding operations will also be conducted. The new Airco-DB No. 1 tractograph and semi-automatic cutting machine, which is used to fabricate parts in the making of road building equipment will also be displayed. The exhibit will be in Booth H-14. The following representatives of the company will be in attendance:

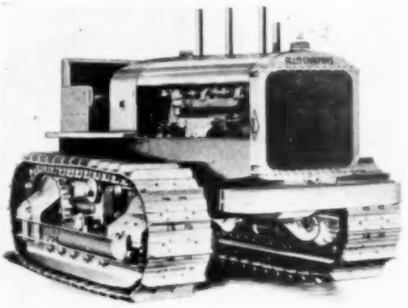
H. F. Henriques, Manager, Cleveland; J. M. Driscoll, Assistant Manager, Cleveland; H. O. Jones, Supervisor, Cleveland; D. M. Llewellyn, Specialist, New York; J. F. Callahan, Advertising Representative, New York; R. Fisher, Salesman, Cleveland; C. M. Hendry, Salesman, Cleveland; G. A. Williams, Serviceman, Cleveland; J. W. Thompson, Serviceman, Cleveland; G. Munson, Salesman, Cleveland; F. L. Huggins, Salesman, Cleveland; L. A. Dupics, Cleveland.

American Sealdrok Inc. Exhibit

The exhibit of the American Sealdrok, Inc., Chicago, will be in Booth H-6, in charge of G. R. March, Chief Engineer, and W. H. Rogers. Their headquarters will be at the Cleveland Hotel.

Allis-Chalmers to Exhibit 12 Units

The new Model "K-T" Hauling Unit, which moves 6 to 8-yd. loads at speeds ranging from 2½ to 16 miles per hour, will be one of several features of the Allis-Chalmers exhibit at the Cleveland Road Show. Allis-Chalmers has planned an exhibit of 12 units.



Model "L-O" Oil Tractor

Heading the A-C display of tractors will be the new Models "L-O" and "L" oil and gas tractors, with a new range of speeds and new controls. The new Models "K-O" and "K" tractors, with a top speed of 5.92 miles per hour, increased power and new controls, will be shown for the first time at a major exhibition.

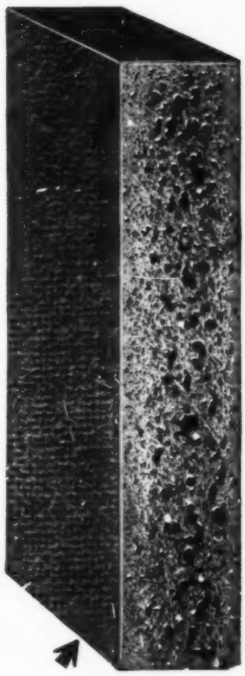
New Model "K-T" Hauling Unit

Four sizes of graders, the 14-ft. power controlled leaning frame, Model 14; the 12-ft. power controlled Model 12; also the new Models 10 and 8, are to be shown. Another feature will be the new Allis-Chalmers line of power units.

The Model "K-T" hauling unit will be in action to demonstrate ease of dumping and winding. An action display will also demonstrate the leaning frame feature and wide range of blade positions on the Model 14 grader.

A premier, consisting of several reels of sound pictures, featuring Allis-Chalmers tractors and equipment, will be shown each day at the exhibit.

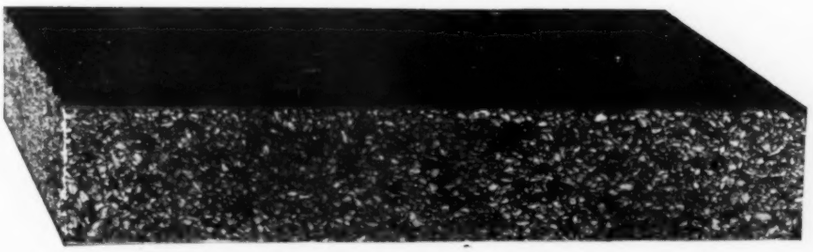
One A-C dealer, E. F. Craven Co. of Greensboro, N. C., has chartered a special car to the Show for the accommodation of its customers and friends.



Sponge Rubber Joint—compressed to 50% thickness—the extrusion .50—recovery one hour 90-95% Felt or Mastic sides.

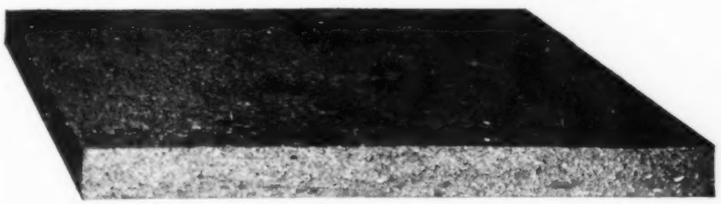
Servicised EXPANSION JOINTS

Cork Rubber Joint

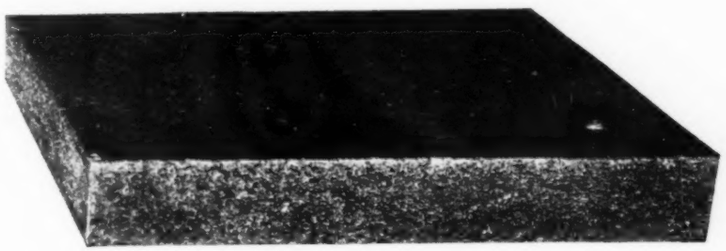


Cork Rubber Joint—compressed to 50% thickness—the extrusion .25—recovery 90-95%.

Felt Sided Asphalt Joint—compressed to 66% thickness—the extrusion .50—recovery one hour 68%—contains 70% Asphalt. Furnished with or without metal escapes or seals.



Cork Fiber Joint—compressed to 64% thickness—the extrusion .42—recovery one hour 71%—contains 38% Asphalt. Furnished with or without metal escapes or seals.



Fiber Joint—compressed to 50% thickness—the extrusion practically nil—recovery one hour 70-75%.

Type B Asphalt Joint—compressed to 66% thickness—the extrusion .42—recovery one hour 70%—contains 65% Asphalt. Furnished with or without metal escapes or seals.

THE above types of joint illustrate SERVICISED service to engineers and contractors in providing both the controlled oozing and non-oozing types of expansion joint. The specifications of the various types are shown under each type and are the minimum and not the maximum tests.

Our types of non-oozing joints will not warp or shrink in the hot sun or hot weather eliminating the necessity of wetting down before using.

The oozing types of joint are controlled by metal escape accessories making provision for the surplus flow under pressure. We also furnish engineers extruded joints for the reception of metal fittings and specialize on extruded products for engineers in State, Municipal, Railroad and Civil work.

SERVICISED service and performance have never been questioned and the same quality is being maintained as heretofore.

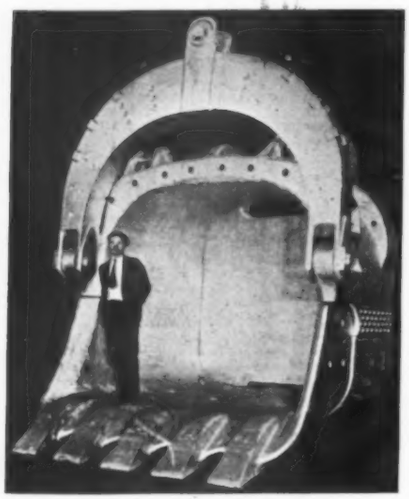
SERVICISED QUALITY PRODUCTS © 1920

SERVICISED PRODUCTS CORP. ● 6051 W. 65th ST. ● CHICAGO

Amsco to Feature Dippers at Show

At the American Manganese Steel Co.'s booth, Amsco renewable lip dippers will be featured—dippers of new design which are now made in sizes from ½ to 18 yd. capacity.

An interesting display of giant enlargements will be shown of products, operating



Amsco 18-*yd. Dipper*

views and details of the 400,000 volt Amsco X-Ray laboratory where pilot castings are "internally" inspected for flaws or defects.

A number of Amsco "old timers," all of them well known to the construction fraternity, will be in attendance, including W. M. Black, W. G. Hoffman, J. P. Murtaugh, W. J. Mullally and others of the sales and engineering staff.

▼

Anthony to Exhibit Three Types of Equipment

The Anthony Co., Inc., Streator, Ill., plans to exhibit three types of equipment.

One is the Anthony No. 1 slant type pipeless hydraulic hoist with the No. 5-B braced side body in 2 to 2½ yd. capacity. Incorporated in the construction is the Anthony automatic patented Shaker—the Anthony patented non-thrust floating gear pump—three way valve control—universal mounting and the adjustable spreader bars as standard equipment. The Anthony high speed safety snow plow, which has been designed and built to meet the demands for high speed, economical snow removal, also will be shown. The plow is so constructed and designed that the blade readily hurdles any permanent obstruction, such as man-hole covers, expansion joints, etc., without the use of springs or gadgets. The blade is supplied in both 8 ft. and 9 ft. lengths and can be swung from 30° right or left from center for casting either right or left or straight across for bulldozing. It is hydraulically controlled from within the cab of the truck by means of hand pump. The Anthony hydraulic digging loader mounted on the Caterpillar Twenty-eight tractor likewise will be on exhibit.

Armco to Exhibit New Products

The Armco Culvert Manufacturers Association, Middletown, Ohio, will exhibit Multi-Plate pipe and arches, metal cribbing, Armco paved invert pipe and Hel-Cor perforated pipe. The latter two products are new or embody new features.

Part of the Armco paved invert pipe will consist of this product, made with "bonded metal." That is, the galvanizing on the interior of the pipe has asbestos felt imbedded in it, and this asbestos is impregnated with an asphaltic product before applying the asphaltic pavement and coating. This is stated to give perfect adhesion, and adds to the durability of the pipe and increases the handling range by making the pavement and coating more adherent and stable—in cold weather and extremely hot weather. This product has been designed especially for sewer use, but will be available for highway use, too.

The second new product is Armco Hel-Cor perforated pipe. It is furnished in 6-in. diameter and is designed especially for subgrade drainage. Its newness lies in its method of fabrication and its construction. Instead of running around the pipe at right angles to its length, the corrugations run helically around the pipe. And the seams, instead of being riveted, are made with a lock-seam. A special exhibit on subdrainage will be featured.

The exhibit will be in Booth G-2, in the Arcade, leading to the exhibition hall.

Those attending for Armco has not been definitely decided, but may include S. R. Ives, M. C. Patton, G. E. Shafer, H. K. Kenyon and W. H. Spindler.

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Barber-Greene Exhibit

The Barber-Greene Co., Aurora, Ill., will have its exhibit in Booth G-10.

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The Barrett Co. Exhibit

The exhibit of the Barrett Co., New York, will consist of photographs and other illustrative material describing Tarvia and its uses. The exhibit will be in Booth F-8 and the following representatives of the Barrett Company will probably be present:

O. A. Brand, Sales Manager, General Tarvia Department, New York City; Paul Macy, Asst. Sales Mgr., General Tarvia Department, New York City; Geo. E. Martin, Consulting Engr., General Tarvia Department, New York City; C. H. Olmstead, Consulting Engr., General Tarvia Department, Chicago; F. E. Banville, Manager, Tarvia Department, Columbus, Ohio; V. C. Otley, Manager, Tarvia Department, Fairfield, Ala.; H. F. Klinker, Manager, Tarvia Department, Chicago, Ill.; A. D. Carpenter, Manager, Tarvia Departmenet, Minneapolis, Minn.; J. H. Sturdevant, Manager, Tarvia Departmeent, Syracuse, N. Y.; F. W. Warner, Manager, Tarvia Department, Philadelphia, Pa.; R. W. Pond, Manager, Tarvia Department, Boston, Mass.; G. P. Soutar, Manager, Tarvia Department, Toronto, Ont.

Asphalt Institute Exhibit

As one part of the exhibit, the Asphalt Institute, New York, will show the range of liquid asphalt, the aggregates with which they are to be used, and sample mixtures of their use. Another part will be models showing stabilization procedure. The remainder of the exhibit will be largely photographs, particularly the new types of work being done.

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A.-W. Exhibit Features New Models

The Austin-Western Road Machinery Co. of Aurora, Ill., will exhibit representative road building, stone crushing and material handling equipment, including:

12-yd. Hydraulic Scraper
No. 10 Hydraulic Control Road Grader
Cletrac 40 Diesel with Trailbuilder
Badger Shovel
10-ton Roll-A-Plane
"77" Sr. Dual Drive Motor Grader with Scarifier Attachment
C. E. P. Crushing Plant.

▼

Bay City Shovels to Show New Machines

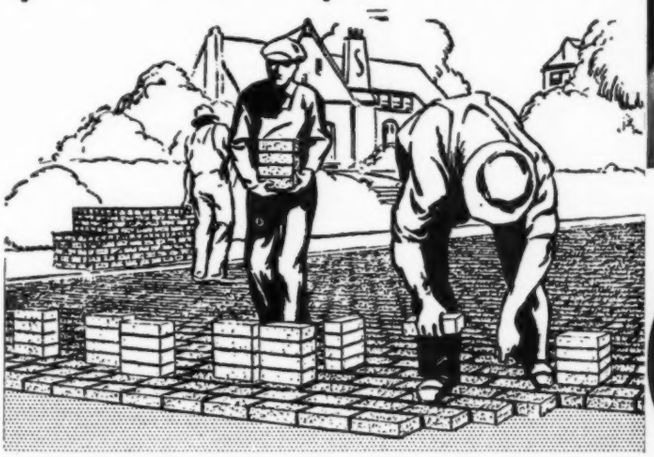
Bay City Shovel, Inc., Bay City, Mich., will exhibit two machines: A Model 62, heavy-duty 1-yd. capacity revolving shovel with diesel power, also new Model 20 full-revolving ⅜-yd. This will be the first public announcement and display of the new full-revolving machine.

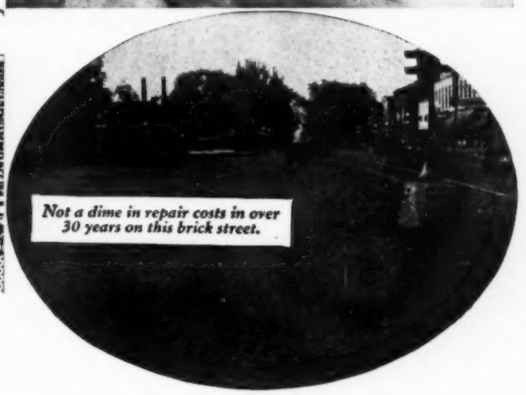
Among the primary refinements and improvements in Bay City design and construction during 1935 was the standardization of uniform design and machinery arrangement for all full-revolving models. Six cylinder gasoline power made standand for all full-revolving models and optional diesel power with various optional makes of diesel engines available for all full-revolving sizes. Cut helical gear drive totally enclosed and running in oil substituted for silent chain, and cut helical gears furnished throughout on all drum and transmission shafting. The use of nickel manganese totally heat-treated unit cast car bodies and upper revolving tables continued on all models, even the smallest sizes for 1936, and more extensive use of special alloy materials have increased strength and elimination of excess weight. Electric operated dipper trip adopted for all full-revolving models, and drop forged crawler shoes on machines of capacities ranging from ⅜ to ⅝ cu. yd. For 1936, Bay City machines are available in ten sizes from ⅜ to 1¼ cu. yd. bucket capacity with bucket available in each fractional size.

The new models are as follows:

A. Model 10—Truck shovel and crane, originally displayed at the Michigan State Road Show, Lansing, in October. This machine fully convertible for operation as shovel, dragline, crane or trench hoe and equipped with full enclosed cab, is available for mounting on or furnished completely mounted on Ford V8, Chevrolet, Dodge, International or other small truck, equipped with Thornton four rear wheel drive. Standard Bay City machine incorporated helical cut gears, frictionless bearings,

After he's grown the Brick Pavement now being laid *will serve him* for years and years . . .





WHEN most of us were about the age of this young chap, the veteran brick roads now in use were built.

For example: After 47 years service, brick-surfaced Buffalo St., Chicago, is now being relayed by WPA.

They were crudely built for horse-drawn traffic. Yet they have stood up under the traffic of a motorized age with a maintenance expense ranging from negligible sums down to absolute nil.

With the better construction of bases and the improved technique of brick surfacing of today, the life and serviceability of brick pavements have been notably increased. Youngsters of today will inherit even greater value in these pavements than did we of the present generation.

• • •

To achieve long life and freedom from repair, a pavement *must* withstand weathering action. Every degree of temperature change—every variation of moisture reacts on pavements unprotected with brick surface. Cracks form; moisture freezes and spalls; traffic finishes the destruction.

Brick are heat-treated until the exteriors of the brick fuse and become vitreous—waterproof. The joints are sealed weathertight. Moisture and temperature damage are kept away from expensive bases.

At a nominal cost and with many important engineering advantages, you may resurface failing pavements with brick and obtain the highest type pavement. Many progressive states and communities have already launched such programs.

Full information available from National Paving Brick Association (Affiliated with Structural Clay Products, Inc.) National Press Building, Washington, D. C.

BRICK

Exhibitor: Highway Exhibit, American Road Builders' Association, January 20-24, Cleveland, Ohio. 30th Annual Meeting National Paving Brick Association at Columbus, Ohio, January 29-30-31, 1936

chain crowd, unit cast machinery table and swing circle. Optional Ford V8, Hercules six, International McCormick-Deering or Chrysler Industrial gasoline engines. This machine is not convertible to crawler mounting but is designed for truck service only.

Model 20, full-revolving ⅜-yd. convertible crawler shovel, to be publicly displayed for the first time at the Cleveland Road Show. With a shovel working weight of ten tons (20 to 21,000 lbs.) this machine is built with all Bay City features and standard design, including unit cast car body, unit cast revolving table, helical cut gears, independent chain crowd, anti-friction bearings, drop-forged crawler shoes and six cylinder power. While designed for the purpose of providing a light, yet tough machine with surplus weight eliminated, this machine is kept about the 10-ton weight class and built with unit cast construction, heavy-duty drop forged crawlers and other requisites for sturdiness and dependable continuous operation.

▼

Bendix-Westinghouse Exhibit

The Bendix-Westinghouse Automatic Air Brake Co., Pittsburgh, Pa., will exhibit Bendix-Westinghouse products consisting of air brakes, air clutch control, air gear shift, air horns, as well as various other items of air control. The latest and probably the most noteworthy advancement in equipment, which will be shown under the Bendix-Westinghouse name, will be in the new low priced automotive air Brake for lighter vehicles, such as Ford, Dodge and Chevrolet. Another newer item will be the independent trailer control valve. This valve as the name implies gives the operator the option of controlling his train either as a single unit or the trailer separately, as conditions demand. The exhibit will be in Space E-2 and the following members of the Bendix-Westinghouse organization will be in attendance:

R. M. Heinrichs, general manager; C. A. Ohl, director of sales; R. L. Morrison, general district manager; F. L. Hall, Eastern district manager; D. W. Scott, advertising manager; J. P. Weber, representative; A. E. Wolfe, representative.

Blaw-Knox to Have Large Exhibit

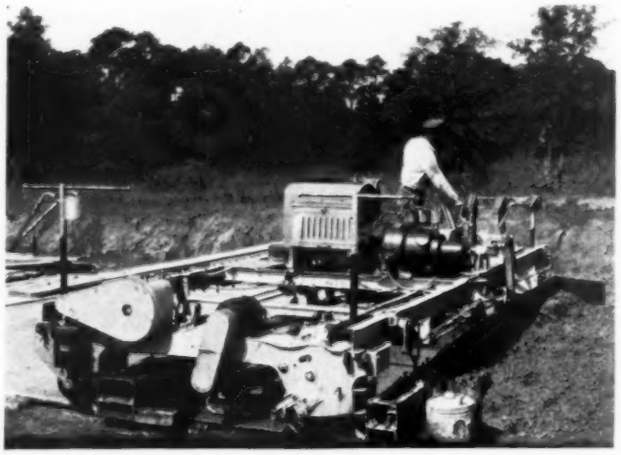
The Blaw-Knox Co., Pittsburgh, Pa.,will exhibit Blaw-Knox road finishing machine, semi-automatic weighing batchers, road forms, street and sidewalk forms, asphalt and stone finish spreaders, clamshell buckets, concrete buckets, dirt-moving equipment and Blaw-Knox Trukmixers mounted on trucks. A gas-electric finishing machine with vibrator, shown for the first time at a road show, is a distinct departure from former types manufactured by the company. Exhibited also for the first time is a Blaw-Knox road finish spreader. This is manufactured in two sizes, models A and B. In the larger size the width of spread can be varied from 5 ft. to 15 ft., and the smaller size from 4 ft. to 10 ft. The machine can be used for spreading and finishing all kinds of plant mixed material, as well as stone, slag and gravel. It is adjustable for any shape of crown and the cross section can be readily changed while in motion for banked curves, etc.

The exhibit will be in Booth D-14 and the representatives who will be in attendance are Chester H. Lehman, vice-president; Robert T. Harris, manager, construction equipment division; Arthur A. Levison, chief engineer, construction equipment division; W. W. Cochrane, manager, bucket division; E. L. Harrington, chief engineer, bucket division; M. Zimmelman and H. L. Guiler.

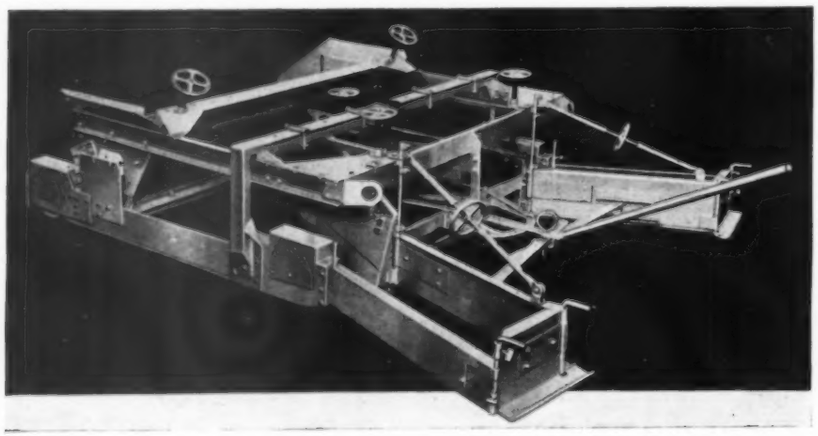
Buckeye to Show New Spreader

The Buckeye Traction Ditcher Co., Findlay, O., will exhibit its Buckeye surface material spreader. On this machine control of flow of the material is by means of a spirally fluted feed roll. This feed roll is driven through a reversing transmission geared to the shaft on which is mounted the wheels that carry the spreader. It is stated that in this way the flow of material is always in direct proportion to the speed at which the spreader is being propelled, assuring a uniform depth of spread. The ruggedly simple coupling device by which the spreader is attached to the truck saves time in changing from an empty to a loaded truck, and it makes operation of the spreader equally effective with the truck moving forward or in reverse. The machine is being exhibited in space F-26.

Snapshot of Buckeye Spreader on a Job



Blaw-Knox Gas-Electric Finishing Machine with Vibrator



Blaw-Knox Road Finish Spreader

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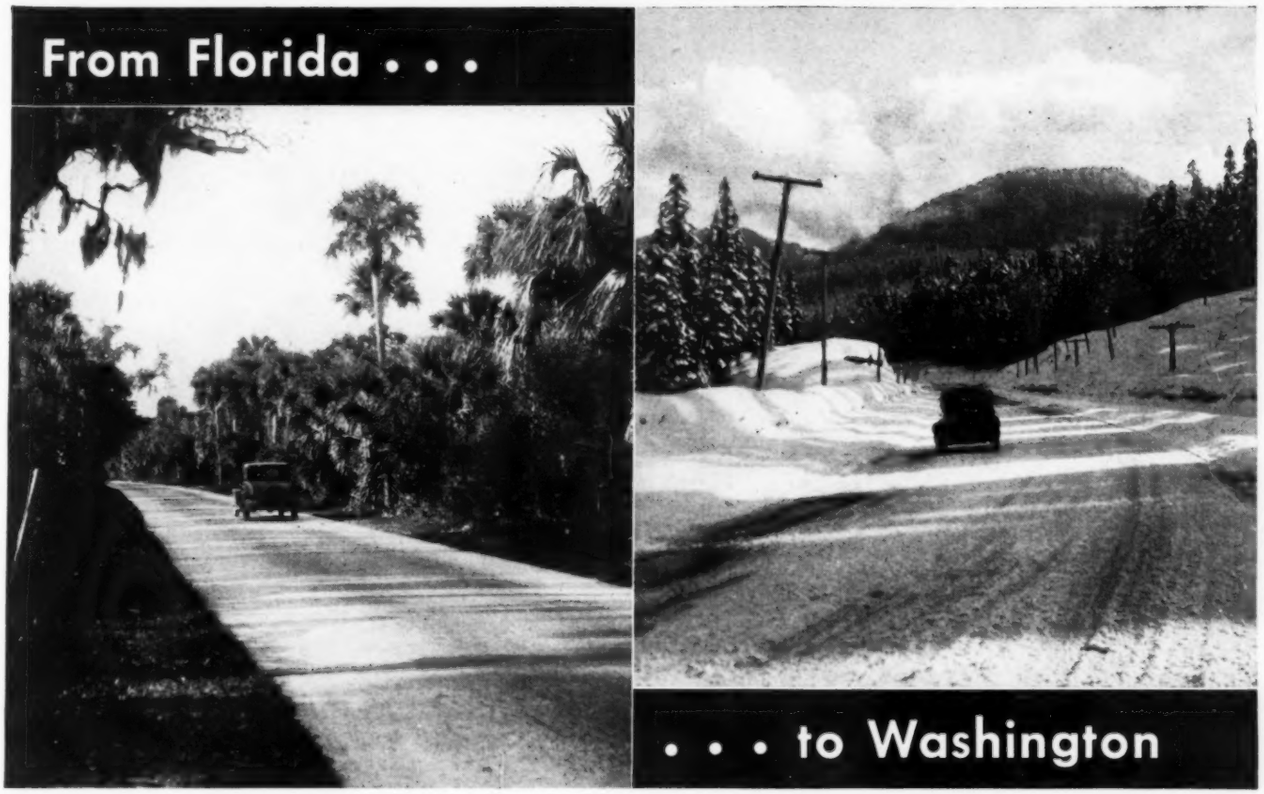
Black & Decker Exhibit

The Black & Decker Mfg. Co., Towson, Md., will exhibit one or two of its portable electric tools, and its loadometers, which are portable weighing devices used for checking the weights of motor trucks on the highways. The exhibit will be in Booth H-38 and will be in charge of E. E. Powell.



Experience of 18 States from coast to coast

shows concrete saves $114 to $469 per year per mile surface maintenance

THE Portland Cement Association has published a summary of the most exhaustive study ever made of comparative surface maintenance costs for various types of pavements.

The summary is based on detailed surface maintenance figures from official records of 18 state highway departments—every state that publishes these records. Figures include the latest records available when the summary was made, January 1935.

Thorough comprehensive analysis

The *consecutive* years of record vary from 3 to 14 and average 7.

Summary includes over 100,000 miles of state highway, almost ⅓ of the total improved mileage.

Concrete costs least

Average surface maintenance cost of 40,388 miles of concrete was revealed as $105.74 per mile per year, ranging from $42.30 to $172.31 in various states.

The paving material next in maintenance cost averaged $220.26, or more than double the cost of concrete. It was also notable that this material which ranked second had a concrete base. The same material with a flexible base had an average maintenance cost of $345.47 per mile per year.

Concrete can take it!

Low maintenance costs for concrete are all the more significant because the average daily traffic on concrete is in excess of 1000 vehicles. Some of the other types enumerated in the summary have relatively little traffic, but heavy maintenance expense.

Concrete has public acceptance

Motorists judge all roads by the standards of safety, economy and comfort set by concrete. They know that concrete lowers their gas, tire and car repair expense—that it is smooth but non-skid—clearly visible at night—swift but safe.

Write for the report entitled "Road Maintenance Costs as told by Available State Highway Records."

PORTLAND CEMENT ASSOCIATION
Dept. A-1-28, 33 West Grand Avenue, Chicago

Broderick & Bascom Exhibit

Broderick & Bascom Rope Co., St. Louis, Mo., will have an attractive exhibit in space H-40. F. A. Flashkamp, J. J. Sieber, an engineer, Geo. T. Born, assistant sales manager, and probably one other representing the firm, will attend the road show.

▼

Bucyrus-Erie to Show New Equipment

The exhibit of the Bucyrus-Erie Co., South Milwaukee, Wis., will be in Booth A-7. The items which it is planned to exhibit are: 10-B (⅜-yd.) excavator and

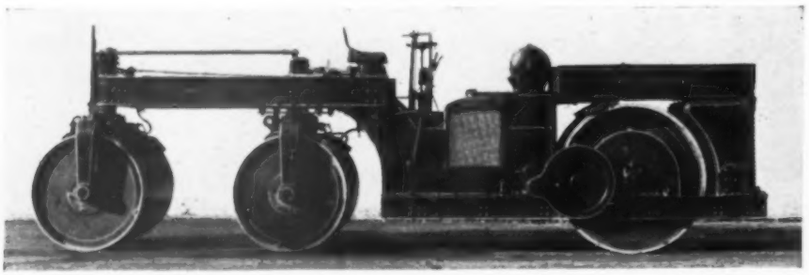
Bucyrus-Erie 10-B *Excavator Cleaning Up Slide Rock for New Mexico State Highway Department*

trailer; 48-B (2-yd.) excavator; two bulldozers; one trailbuilder; two (6-7-yd.) scrapers; and a 2-yd. type "AX" red arch dragline bucket. All of these are new in the Bucyrus-Erie line.

▼

Buffalo-Springfield to Show High Compression, 3-Axle Rollers

The Buffalo-Springfield Roller Co., Springfield, O., will have an exhibit in Space F-22 consisting of about 1,000 ft. and will show two types of high compression 3-axle rollers and also a small tandem of light compression for rolling brick footpaths, etc. One of the high compression



Buffalo-Springfield 3-Axle Tandem Roller

rollers to be shown will be a 3-axle tandem such as illustrated. The machine is so designed that extra pressure is automatically applied to high areas, reducing the surface to a precise plane. The king pin of the outer guiding roll can be released for vertical movement if desired. The rolls are capable of being filled with water ballast, and consequently the working weight of this roller is greater than that of any other roller now manufactured.

The exhibit will be in charge of W. J. Hazeltine, sales engineer, and also attended by C. J. Foster, vice-president; E. E. Greiner, treasurer; J. F. Richardson, secretary and sales manager; A. W. Aitken, engineer, and the branch managers, E. C. Touhey of New York, George P. White of Philadelphia, and Albert Peck of Buffalo. The New England branch will be represented by E. W. Bryant.

Butler Bin

Butler Bin Co., Waukesha, Wis., will occupy Space F-29. In attendance will be M. R. Butler, A. R. Morton and H. W. Butler.

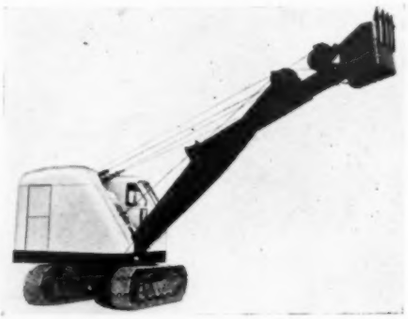
▼

Byers to Show New Shovels

The Byers Machine Co., Ravenna, O., will exhibit its ½-yd. full revolving Model 62 and its ⅜-yd. three-quarter swing Bear Cat Jr. Neither have been exhibited before at any show. The Model 62 is Byers' latest machine. It utilizes 32 Timken roller bearings with the result that both the vertical and horizontal swing shafts, the deck shafts, also the swing, crowd and travel clutches operate with a minimum of friction in roller bearings.

The manufacturer states that this roller bearing construction provides a faster start on every swing and cuts 20 to 30 per cent off the swinging time required. These bearings and the moulded friction clutch linings eliminate grabbing, chattering and the rapid wear on clutch facings.

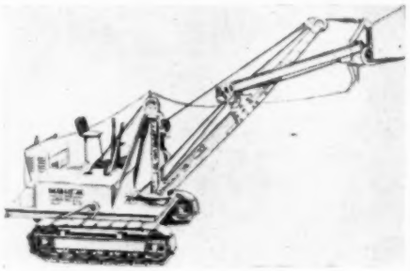
Another feature of the Model 62 is that only three main assemblies and one shaft assembly in the lower deck are required to perform all hoisting, swinging, crowding, traveling and steering operations. No additional machinery other than drum lagging is needed to operate shovel, clamshell, dragline or trencher attachments. All gears



Byers Model 62 ½-yd. Full Revolving Shovel.

operate in oil. The bucket trip is power actuated. Controls are placed immediately in front of the operator where he can perform all operations while seated. Power is applied direct to hoist, swing, crowd and propel shafts, eliminating friction waste of intermediary gears. The shovel is furnished with independent cable or chain crowd. With simplified chain crowd it is unnecessary to take off or put on additional machinery (except split chain drum sprocket) when changing from clamshell to dragline or shovel attachment and vice versa.

Two travel speeds are provided in both forward and reverse—low gear for 30 per



Byers Bear Cat Junior.

cent grades and high gear for a speed of 132 ft. per minute. Crawlers can be steered to right or left in a sharp or long turn, in high or low gear while traveling forward or backward, and can be locked from operator's seat to prevent rolling backward while working.

Steering mechanism is simple and easy to service. One shaft assembly performs all travel and steering operations. A single-lug tread design assures self- cleaning crawler treads. Crawler traveling sprockets mounted on square billets remove the necessity for the use of keys. To hold the crawler assembly in positive alignment, crawler bolsters are of cast steel. Crawler traveling chains have a 400 per cent factor of safety and provide high under-axle clearance.

This Model 62 has a modern styled, larger cab with sliding doors and more windows for visibility. A low cost, pneumatic tired, roller bearing mounted trailer capable of speeds of 30 to 35 miles an hour is available for moving Model 62. It can be loaded or unloaded by two men in 10 minutes.

The Bear Cat Jr.'s outstanding features are its portability by truck, on its own low priced trailer at speeds of 30 to 35 miles per hour, or on its own crawlers in high speed of 4 miles per hour. All operations of traveling, steering from both crawlers, swinging, independent crowding and hoisting are accomplished through only three operating shaft assemblies on the fully-enclosed machinery deck. The travel shaft is located on the machinery deck; there are no shafts below the main frame. A 3-speed transmission between the motor and take-off gear provides three travel speeds and two operating speeds, for ordinary or light digging. The gear-driven swinger can be positively locked to prevent swinging while traveling. All machinery is protected by an automobile type of hood enclosure and motor hood can be locked to prevent theft of gasoline and accessories. The motor is a 4-cylinder, slow-speed, industrial type, developing 30 h.p.

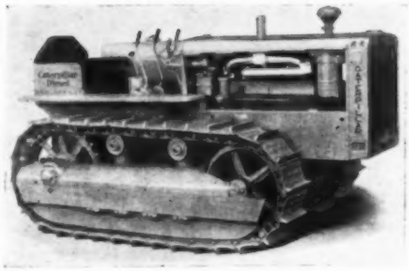
The exhibit will be in Booth D-11. The following will be at the Road Show: W. C. Horr, President; P. T. Redfern, Sales Manager; L. T. McGuire, Asst. Sales Manager; C. J. Fulweber, Secretary and Treasurer; Geo. E. Miller, Chief Engineer; H. R. Jones, Service Manager; S. R. Teager, Production Manager; R. S. Hutchison, District Sales Manager; E. M. Ornitz, District Sales Manager; C. W. Weaver, Demonstrator; F. A. Wilhelm, Demonstrator; M. Q. Norman, Demonstrator.

▼

"Caterpillar" to Have Large Display

An elaborate display of its new line of tractor and engine products, covering 4,500 sq. ft. of floor space, will be exhibited by Caterpillar Tractor Co., Peoria, Ill.

Center of interest and highlight of the exhibit will be the company's 10,000th diesel, which powers a "Caterpillar" RD6 tractor. The tractor rolled off the assembly line Nov. 13 and represented the 10,000th diesel engine built by the company in a little more than four years of diesel production.



New RD4 Diesel Tractor

All four members of the new line of diesel tractors, the RD8, RD7, RD6 and RD4, ranging from 95 to 35 drawbar horsepower, will be displayed at the show. Also shown for the first time will be the D-17000 diesel. 160-H.P., V-type, 8-cylinder power unit, and the D4400 unit of 44-H.P., 4-cylinder design.

The new diesel auto patrol with its long front axle, tandem drive and low pressure tires will be exhibited. The No. 66 power-controlled grader, the new No. 22 grader, together with the trailer and Hi-Way patrols, also will be shown.

In addition to the company's exhibit proper, its products will be displayed by a large number of allied manufacturers of compressors, crushers, generator sets, shovels, cranes and industrial locomotives who use "Caterpillar" engines to power their standard models.

The color plan of the "Caterpillar" display will be yellow and black, and the exhibit number is B-17, located on the ground level of the Auditorium annex. Representatives of the company who will be in charge include I. J. Howald, Ralph Morgan, C. A. Spears, Frank Nikirk, O. Q. Hinds and W. K. Cox.

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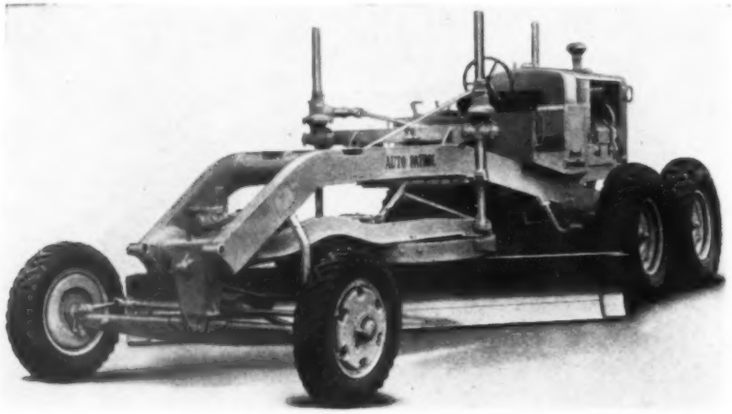
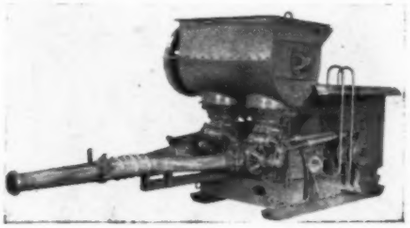
Chain-Belt to Feature "Pumpcrete"

The exhibit of the Chain Belt Co., Milwaukee, Wis., will include one 1½-yd. Motor mixers, two 2-in. pumps, one 3-in. pump, two 4-in. pumps and one 6-in. pump. These are all self-priming centrifugal. It also is intended to show one cold patch mixer and one electrically driven self-priming centrifugal pump. The latter will be shown in actual operation, as will the main feature of the exhibit, which is a Rex Pumpcrete, "the pump that pumps concrete."



New Diesel Auto Patrol

Those in attendance will be C. R. Messinger, president; G. K. Viall and B. Welser, vice-presidents; A. R. Abelt, secretary; C. L. Pfeifer, treasurer; G. M. Dyke, assistant treasurer; B. F. Devine, sales manager in charge of construction equipment; A. E. Miller, M. Mills, G. A. Cooper, J. C. Wisner, district managers; C. F. Ball, chief engineer; M. Jewett, metallurgist; L. B. McKnight, sales manager in charge of the Conveyor Division; C. I. Longenecker, engineers; D. A. Kaltoske and J. H. Ebershoff.



Rex Pumpcrete

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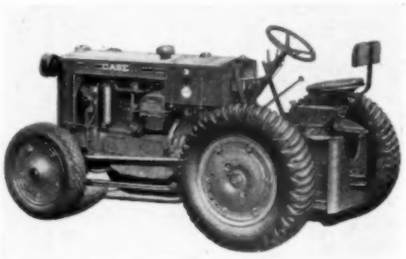
Case to Show Its Latest Tractor

J. I. Case Co., Racine, Wis., will occupy Space A-14, where the latest type of Model LI Tractor with 4-speed transmission with low-pressure tires front and rear, will be shown. In attendance at the Road Show will be G. W. Iverson, Sales Manager, Industrial Division; E. H. Anderson, M. C. Anderson and M. R. Comer.



Case Model LI Tractor.

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Chicago Pneumatic to Show New Compressor

The Chicago Pneumatic Tool Co., New York, N. Y., will exhibit its new two-stage, air-cooled portable compressor. In addition there will be on exhibition a demolition tool, shimmy spade (concrete vibrator), clay digger, sheeting driver and rock drill.

C. P. Two-Stage Air-Cooled Portable Air Compressor.

Chicago Rawhide to Exhibit Entire Line

The Chicago Rawhide Mfg. Co., Chicago, will have a complete exhibit of its entire line of products but, will particularly stress its oil seals and grease retainers and the part they play in the protection of bearings on the type of equipment being exhibited at the show. In addition to its standard perfect oil seal, particular emphasis will be given its dual types of oil retension and dirt exclusion. The company will have a new visual demonstrating machine operating at normal axle shaft speed which will give visual evidence of the efficiency of these devices as far as exclusion of materials from one compartment to the other is concerned.

▼

Construction Machinery Co.

The Construction Machinery Co., Waterloo, Ia., will occupy Booth F-17A. G. A. Loveall, Sales Manager, and L. S. Holden, Secretary-Treasurer, will represent the company at the show.

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Cleveland Rock Drill Exhibit

The Cleveland Rock Drill Co., Cleveland, O., will exhibit its full line, including about twelve types of jackhammers, nine sizes and styles of paving breakers and pneumatic diggers, its backfill tamper and its two types of wagon drills or drill rigs. In addition there will be a full line of accessories such as drill steel, paving breaker chisels, spades, couplings and valves. The exhibit will be in space F-28. Representatives of the company who will be on hand practically all of the time are the following: Geo. H. Hall, sales manager; R. R. Morgan, assistant sales manager; J. C. Curtis, chief designer; E. L. Oldham, advertising manager; L. L. Richardson, superintendent, and C. L. Seaman, northern Ohio representative.

Model DRC Drill Rig

Cleveland Tractor to Introduce New Models

The Cleveland Tractor Co., Cleveland, O., will occupy a space of 3150 sq. ft., in which will be shown the complete line of tractors and special equipment used with them such as carry-all scrapers, air compressors, trailbuilders, front end loaders, snow plows and other industrial road equipment.

A number of new models also will be introduced. One of particular importance will be the new Cletrac BD which will be a Diesel crawler tractor of approximately 30 HP.

Another interesting feature of the exhibit will be a duplicate of the tractor used by Admiral Byrd at the South Pole during their second Antarctic Expedition. Also during the entire week of the Road Show Commander Noville, who was Mr. Byrd's First Executive Officer on this trip, who had charge of tractor operations, will be in attendance and he will give a lecture several times a day in the movie room provided by the Road Builders in which a movie showing scenes of the Byrd Expedition at Little America, together with some films of the Cletrac in use at the South Pole.

Cletrac Hauling Plane from Little America to Landing Area at Edge of Barrier

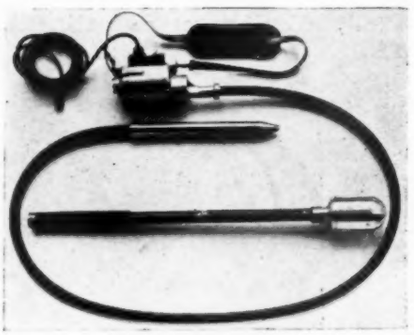
Included in the exhibit around the Byrd tractor in the space will be an exhibition of Antarctic Polar equipment such as the sleds that were used to haul supplies, a portable field wireless outfit and a portable sled wireless outfit, special portable stoves that were used together with a complete outfit of Antarctic clothing, ice picks, rubber boots, etc.

▼

Concrete Machinery Co. to Show Vibrators and Surfacers

The Concrete Surfacing Machinery Co., Cincinnati, O., will have a display of "Berg" products in Booth H-17, in charge of M. Wetstein, President. The exhibit includes many models of "Berg" concrete surfacers. Among the machines shown, are electric motor and gasoline engine driven models with various attachments for concrete surfacing and other applications.

Of special interest at this time, will be the "Berg" vibrator units in two sizes, both arranged for attachment to a flexible shaft and casing and driven by a high speed electric motor of man carrying portability. The latest addition to the "Berg" line, the 1⅞-in. diameter vibrator unit, will be shown. It was developed recently to meet the demand for an internal vibrator of small diameter, for vibrating between narrow forms. These vibrator units and the various attachments for concrete surfacing, are all interchangeable on the same motor unit.



"Berg" Concrete Vibrators—Electric Motor Driven—1⅞-in. Diameter and 5-in. Diameter.

The "Berg" Hi-way surfacer also will be shown with a clutch take-off assembly and rubber tired wheels. The power take-off, which is an exclusive feature, permits this machine to be used for surfacing walls, bridges, culverts, as well as for removing surface irregularities from concrete and concrete-asphalt roads.

▼

Commercial to Exhibit Hoists for Truck

The Commercial Shearing & Stamping Co., Youngstown, O., will exhibit three different body styles—one showing its model "F" line, another its model "H" line, and another its well-known "3-way" body. The following men will represent the company at the Road Show: G. F. Alderdice, Jr., Wm. H. Alderdice, Herman Wollison, Joseph L. Gillman, Jr., W. C. Wright, L. I. Lipp.

Continental to Show New Line

The Tractor Equipment Division of the Continental Roll & Steel Foundry Company, Chicago, Ill., is planning to exhibit several new items of construction equipment at Booth B-8 and B-9 at the forthcoming Road Show.

The new Continental Trailbuilder, the new Continental bulldozer, the Roll Clear ripper and a 7 yd. Continental wagon scraper will be shown.

Continental Wagon Scraper

The Continental scraper will be in operation to graphically demonstrate its many salient operating features.

The new Continental bulldozer which features radical design changes and greatly improved operating advantages, is made for use on Allis-Chalmers, McCormick-Deering and Cletrac tractors—the Continental Trailbuilder being available for the same makes of tractors.

The Continental line of construction equipment has been broadened during the past year. A complete line of equipment is now offered for the construction field, including rippers, scrapers, bulldozers and trailbuilders in a wide range of sizes and models.

▼

Dow Chemical to Feature Uses of Calcium Chloride

The Dow Chemical Co., Midland, Mich., will feature the major uses of Dowflake calcium chloride which include dust prevention, concrete curing, and ice control. Special stress will probably be laid on the use of calcium chloride in construction and maintenance of stabilized roads, including methods and equipment for plant stabilization.

The booth number is D-3 and will be in charge of Harold Knowles. Other representatives who will be in attendance are: Don Williams, Frank N. Whaley, John A. Lewin, Wallace C. Curran, George Hemmerick and Leroy C. Stewart.

▼

Electric Wheel Co. to Show Its Latest Developments

The exhibit of the Electric Wheel Co., Quincy, Ill., will consist of various types of wheels, showing the company's latest developments in wheel designing. Industrial mountings also will be shown, one mounting being in connection with a Caterpillar diesel power unit. The exhibition will be part of the Caterpillar group. F. F. Alexander, Sales Manager, will be in charge.

Cummer to Show Screen and Mechanical Timer

F. D. Cummer & Son Co., Cleveland, O., will exhibit one of its 2-ton mixers, a dial scale, a vibrating screen and a mechanical timer. The exhibit will be in booth F-11 and I. Preeman, vice-president, will be in charge.

▼

Euclid to Feature Trac-Trucks

The Euclid Road Machinery Co., Cleveland, O., will feature its Trac-Truks. The exhibit will be in space C-27. The entire organization of the company will be present. Arrangements are being handled by E. F. Armington, vice-president and sales manager, and H. E. Orr, assistant sales manager.

▼

Fairbanks-Morse to Feature Diesels

The industrial equipment of Fairbanks, Morse & Co., Chicago, will be displayed in Booth C-17. There also will be a display of magnetos in Booth C-11.

The Industrial Booth, which is 50 ft. wide on the aisle and 10 ft. deep, will include two diesel power units, a gasoline power unit, a gasoline engine driven lighting plant, a concrete aggregate scale, a printomatic weigher dial scale, a self-oiling power pump with tandem motor-drive, a built-together motor-pump unit and several types of ball bearing motors. Diesel engines will be featured in the exhibit.

The representatives will include T. B. Robie, E. A. Bence, F. H. Dickson, George Worthley, J. S. Peterson, R. F. Koops, R. L. Johnson, W. J. Burchill, and E. E. Lundquist.

▼

FWD Exhibit Features Streamlined Road Maintainer Unit

A streamlined FWD (four-wheel-drive) road maintainer will be the main feature of the exhibit of the Four Wheel Drive Auto Co. of Clintonville, Wis.

The engine develops 85 B. H. P. The wheelbase is 148 in. and on the heat-treated frame is mounted a 2½ yd. dump body. Located transversely under the center of the truck is an electric hydraulic

Streamlined FWD Road Maintainer Unit.

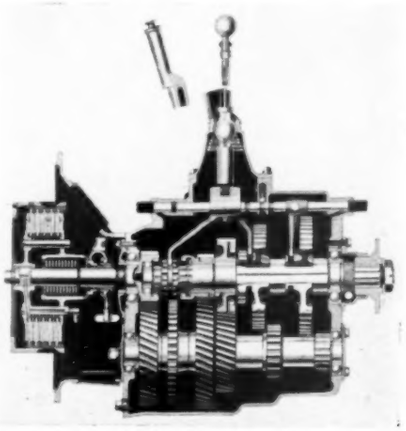
spring scraper with a 10 ft. blade. Six forward speeds and two reverse are provided by a sliding gear type transmission. This arrangement actually gives three maintaining speeds and three hauling or road speeds. Safety and dependability are further assured through the added traction of four-driving wheels, shatterproof glass in cab and four-wheel hydraulic brakes—booster operated.

FWD officials and distributors who will attend the road show are as follows: Walter A. Olen, president and general manager; R. H. Schmidt, general sales manager; S. H. Sanford, manager of the dealer division; H. M. Daniels, supervisor of eastern branches; I. F. Toombs, Ohio State distributor; F. A. Brown of Pittsburgh, Pa.; A. B. Polzin, La Porte, Ind.; R. H. Carter, Raleigh, N. C.—all district sales managers, and E. F. Regal, sales representative, New York branch.

▼

Fuller Mfg. Co. to Exhibit Truck Transmissions

The Fuller Manufacturing Co., Kalamazoo, Mich., will exhibit a line of 5-speed heavy duty truck transmissions.



Fuller 5-Speed Heavy Duty Truck Transmission.

The exhibit will be in Booth D-2. The following is a list of representatives who plan to attend the road show: W. Peapples, Secretary and Treasurer; E. L. Ludvigsen, Sales Manager; C. A. Cook, Chief Engineer; W. E. Niness, Sales Engineer; T. Backus, Sales Engineer; E. L. King, Service Manager.

▼

Galion Allsteel Body Co. to Show Improved Hoist

The Galion Allsteel Body Co., Galion, O., will exhibit an improved hoist model GH-56 with model 12 body. The body will also carry new improvements for 1936. A hoist model GH-57, the heavy duty hoist, for trucks ranging from 2 tons to 5 tons also will be shown.

The exhibit will be in Space F-20 and the following will be in attendance: G. L.

Heavy Duty Hoist, Model GH-57

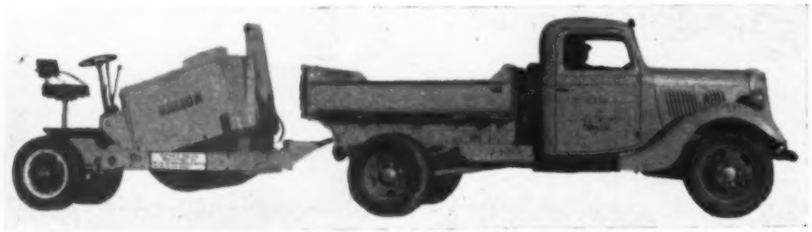
Stiefel, President; B. J. Heiser, Manager of Sales; E. Krieger, Representative; J. L. Brown, Representative; J. C. Gay, Engineer.

▼

Galion Iron Works to Show New Items

The Galion Iron Works & Mfg. Co., Galion, O., will exhibit a 12-ft. hydraulic power operated blade grader; a Diesel powered motor grader; a tandem roller; a patch roller and a three-wheel roller equipped with a roll-a-plane attachment. Three of these items are new. The exhibit will be: Space E-10 and it is expected to have the following representatives in attendance:

J. S. Boyd, C. F. Boyd, H. G. Hulse, R. E. Boyd, J. L. Connors, Y. T. Leftwich, J. E. Morton, R. E. Forsythe, E. J. Saxton, A. Henry, A. L. McCallum.



New Patch Roller Attached to Small Truck for Transportation

▼

Gardner-Denver to Feature 420-Ft. Diesel Compressors

The Gardner-Denver Co., Quincy, Ill., will exhibit the following: A 420 ft. portable compressor with Caterpillar D-13000 engine. A 105 ft. portable compressor with Buda gasoline engine. A WD-3 large wagon drill. A UMA small wagon drill, and full line of jackhammers, concrete breakers and clay diggers. The feature item will be the 420 ft. diesel driven portable air compressor with Caterpillar D-13000 engine. The exhibit will be in Booth B-1, and R. H. Pearson will be in attendance.

420 *Ft. Diesel Driven Portable Compressor.*

▼

Gruendler to Display Two Units

The Gruendler Crusher & Pulverize Co., St. Louis, Mo., will have two units for display purposes. One unit will be a small working model of a roller bearing jaw crusher, together with elevator, screen and bins, and the other will be the company's popular sixe 2XB Limestone Pulverizer. The exhibit will be in Booth C-9 and will be in charge of Mr. Wm. P. Gruendler and he will be assisted by Mr. H. B. Fuller, Cleveland representative, and T. A. Oberhellmann, Chief Engineer.

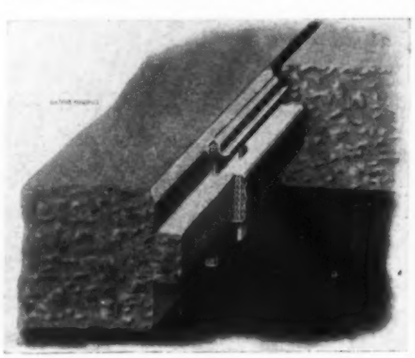
Gar Wood to Exhibit in Three Booths

Gar Wood Industries, Inc., Detroit, Mich., will exhibit in three large booths. The hoist and body division will decorate their 1120 sq. ft. of space in Booth D-20 with large photo murals displaying the many lines of equipment built by the company. Plenty of comfortable seats as well as a check room are to be provided for the comfort of all visitors. No equipment is being shown in the booth. However several Wood hoists and bodies will be at the show, mounted on the chasis of a number of exhibting truck manufacturers. Mr. Logan T. Wood, vice-president; Mr. W. H. Hammond, manager Hoist and Body Division; Mr. C. D. Macpherson, Mr. R. J. Hymberg, and Mr. G. E. Robinson, manager of the Winch Division, will attend. The Road Machinery Division of the Company will show a roadbuilder installed on a Caterpillar RD-8 tractor, a 6 cu. yd. scraper and ripper in Booth B-5. In Booth A-10, they will exhibit a roadbuilder on Cletrac 80 and a 12 cu. yd. scraper. J. B. Haile, manager of the Road Machinery Division and A. C. Borg, assistant manager, will be in attendance.

▼

W. S. Godwin to Exhibit New Expansion Joint

W. S. Godwin Co., Baltimore, Md., will show samples of its steel paving and curb guards for protecting the edges of all classes of paving, curbs, railroad crossings, etc. In addition a new air-lock expansion joint for concrete roads will be shown. The air-lock expansion joint forms are strongly formed from sheet steel in lengths and heights and with triangular shoes for thickened edges required by different paving specifications. Air spaces are provided by means of inserted strips of collapsible water-proofed material, held in place by clips stamped from the sheet steel. Each complete section is coated with asphaltic paint. Sections are held on the subgrade with heavy steel stakes. The air-lock expansion joint acts as a form while the concrete is setting; it has no function whatever after the tongue and groove joint is formed in the concrete.



Godwin Air-Lock Expansion Joint.

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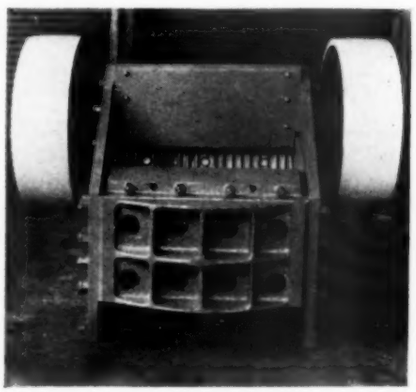
Gorman-Rupp Co. to Show Pumps

The exhibit of the Gorman-Rupp Co., Mansfield, O., will consist entirely of their line of self priming centrifugal pumps. The exhibit will be in Booth C-7. J. C. Gorman, President, will be in attendance during the show and Mr. Rupp will be there probably for two days.

▼

Good Roads to Show Improved Roller Bearing Crusher

The Good Roads Machinery Corporation, Kennett Square, Pa., will have one of its No. 1030 "Good Roads" Champion roller-bearing crushers running, with small electric motor furnishing the power with cog-belt drive. The crusher itself will weigh about 14,000 lbs. In addition there probably will be some small models and some good pictures. The exhibit will be in Booth E-4.



New "Good Roads" Champion Roller Bearing Crusher

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Haiss to Exhibit Largest Bucket Loader

George Haiss Mfg. Co., Inc., New York, N. Y., will exhibit its model 135 loader, which is stated to be the largest machine of the bucket loader type which has yet been developed or is on the market. It has a capacity of over 5 cu. yds. per minute. It weighs approximately 24,000 lbs. The elevator buckets are 3 ft. wide. This machine will be set on blocks and operated at partial speed by an auxiliary electric motor so that the controls and operation of the machine can be fully demonstrated.

▼

Heltzel to Exhibit Forms

The Heltzel Steel Form and Iron Co., Warren, O., will exhibit full sized sections of Heltzel steel forms for highway, city streets and side walk construction. Also models of bins and batchers and photographs covering latest improvements to standard and new products. The following members of the organization will attend the road show in Cleveland next month: J. N. Heltzel, J. William Heltzel, Frank McCaffery, B. M. Clark.

Hargrave to Show New Equipment

The exhibit of the Hargrave Construction Co., Cedar Rapids, Ia., will include a grader-planer attachment for mounting on any grader or motor patrol. The attachment is used for scarifying bituminous mats, mixing, discing, planing, smoothing, breaking up large chunks of oil mats. It also can plane and smooth asphalt streets.

A disc sharpener stated to be capable of sharpening the disc in a few minutes will be shown, and a new vacuum street sweeper also will be on exhibit. This machine, it is claimed, will suck all dust and dirt from the road surface prior to application of bitumen, and blow it completely off the right of way. The discharge spout can be turned in any direction desired, in order to blow with the wind. The exhibit will be in booth B-19 H-19 and headquarters will be at the Auditorium Hotel.

Grader-Planer Mounted on Circle of a Motor Patrol After the Mold Board Has Been Removed. Attachment is Hung on the Same Hangers Holding the Mold Board

▼

Hetherington & Berner to Exhibit Mechanical Timing Device

Hetherington & Berner, Inc., Indianapolis, Ind., will exhibit their mechanical timing device for asphalt mixers. They will also have photographs of various plants and their component parts which they manufacture. They will be represented at the Road Show by Robert B. Berner, A. T. Clay, and Robert Berner.

▼

Harnischfeger to Announce New Shovel

The Harnischfeger Corporation of Milwaukee, Wis., will exhibit an entirely new excavator, the Model 765, a machine of 2 cu. yd. capacity. The 765 is one of the new series of P&H 700 machines, a line which has been completely redesigned to take advantage of the recent developments in alloy steels and arc welded construction for greater strength with less weight. In designing these machines, Harnischfeger engineers have taken advantage of several P&H features which suit them especially well for the adoption of Diesel power. Although the 765 is also available with gas, this model is powered by an 8-cylinder, Fairbanks-Morse 4-cycle Diesel engine, rated at 165 hp. at 1200 r.p.m. Among the other exhibits at the Harnischfeger booth will be a new P&H 150-ampere welder mounted on an automotive type trailer with pneumatic tires. This unit, designed primarily for field service, has some interesting new features. Harnischfeger welding experts will be on the job with a continuous demonstration where practical methods will be explained and questions answered. The Harnischfeger exhibit will also include electric hoists, motor and light plants.

Huber to Show New Roller

The Huber Manufacturing Co., Marion, O., will show for the first time its new type 10-ton roller. This is equipped with a 6-cylinder, heavy duty motor. The motor has removable sleeves. The roller has three speeds forward and three in reverse. This roller is equipped with what is known as dual steering, making it possible to use either hand or power steering. Both are operated hydraulically and an instant change may be made from one to the other.

The new Huber Superior motor grader also will be shown for the first time. These are being built in two sizes—No. 4 and No. 5. These graders are equipped with a heavy duty 6-cylinder motor, have five speeds forward and two in reverse, all controls are hydraulically operated and it has dual steering the same as the motor roller. In this grader the motor is placed in the front of the machine. The power is transmitted to the rear and the blade is pushed from the rear axle the same as a fulldozer.

▼

Hyatt Exhibit

The exhibit of the Hyatt Roller Bearing Co., Harrison, N. J., will be in space F-2. In their exhibit will be illustrated the various makes and types of road building and contractors' equipment employing Hyatt roller bearings. Those in attendance will be Messrs. H. K. Porter, general sales manager; C. L. Newby, manager of the western division; J. M. Kelly, manager of the central division; W. L. Iliff, manager of the eastern division; H. M. Carroll, advertising manager, and B. Barbe, L. L. Hill, L. F. Stuebe, F. H. Webster, L. C. Fisk, sales engineers. The Hyatt headquarters will be at the Hollenden Hotel.

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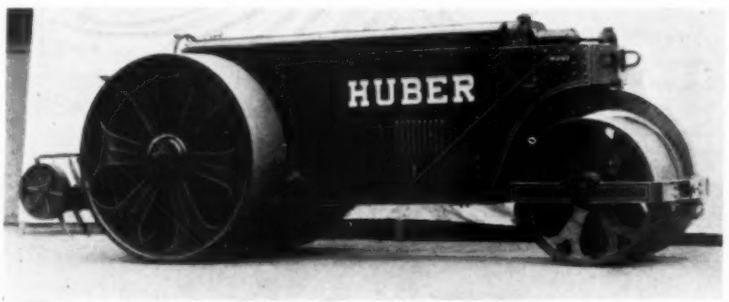
Iowa Mfg. Co. to Display New Rolls

The Iowa Manufacturing Co., Cedar Rapids, Ia., will have on display its new type of roller bearing jaw crusher with the SKF bearings—New Roll Crusher, as



New Huber 10-Ton Roller

New Huber Superior Motor Grader

per the attached bulletin (30x18 size) and our New Symons Screen for use on portable plants, as per the attached bulletin. We are also going to show a working model of the Standard-Cedar Rapids Asphalt Plant, and you perhaps know that we have the exclusive manufacturing and selling rights on the Standard line East of the Rocky Mountains.

▼

International to Exhibit Three Groups of Equipment

The International Harvester Co., Chicago, will be among the largest exhibitors. A wide variety of equipment will be on display in its exhibit and will be divided into three groups—one consisting of five types of tractors, another of four types of motor trucks, and the third of seven types of power units.

Included in the display will be several new developments. Among these are one of the new line of eight International six-wheel motor trucks, one of the new line of five International two-speed axle motor trucks, and a new 100-H.P. power unit (the International model PA-100).

The new International six-wheel motor trucks are of either the trailing-axle or dual-drive type. The model displayed at the road show is of the dual-drive type, a model C-55-F rated at from 3½ to 7 tons

The new line of two-speed axle Internationals is represented at the road show by the 1½-ton model CS-30 equipped with dump body. With two-speed axle construction all the advantages offered both by the high-speed and low-speed axle ratios are combined in one unit. A cutaway of the two-speed axle will also be on display and will greatly facilitate the study of this interesting line of new trucks.

The new model PA-100 power unit to be displayed is provided with six replaceable cylinders and develops a maximum of 115 H.P.

The International model TD-40 Diesel TracTracTor and model PD-40 Diesel power unit also are to be shown. The model TD-40 Diesel TracTracTor is operated by a 4-cylinder, 4-stroke-cycle, valve-in-head Diesel engine and is equipped with the same type of crawler chassis as the International 6-cylinder model TA-40 TracTracTor. The model PD-40 Diesel power unit is also of four-cylinder type.

Study of this Diesel engine used in International TracTracTors and power units by road show visitors will also be facilitated by the display of a cut-away engine.

Other special exhibits include a cut-away heavy-duty motor truck engine, clutch and transmission and a lower track roller and driving sprocket of the model T-40 TracTracTor. Finally, a special motion picture theater will form an important part of the exhibit in which sound pictures showing International equipment in a variety of interesting operating scenes will be continually running.

▼

Jaeger to Have Large Exhibit

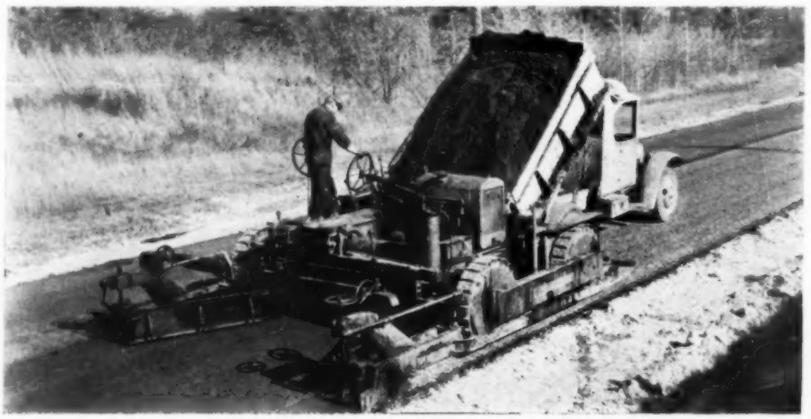
The principal items in the exhibit of The Jaeger Machine Co. (and its subsidiary the Lakewood Engineering Co.), Columbus, O., include the following: From its paving equipment: The Jaeger bituminous paver, the Jaeger triple pugmill road builder, the Jaeger-Lakewood type "D" finisher, the Jaeger AJS spreader box. There also will be a truck mixer featuring the high and low range transmission, together with a full line of contractors' self-priming pumps.

The newest development is the Jaeger triple pugmill road builder which is used in connection with both bituminous and stabilized road mixtures. This machine gathers the material from the road surface passing it through a double pugmill mixer and then to a single pugmill mixer from the last mixer it is distributed in front of an adjustable strike-off mounted on long equalizing runners, which are so attached to the machine that they are free from any movement imparted by the mixer proper. This machine can be furnished in the proper width for half width construction of roads up to and including a total of 24 ft.

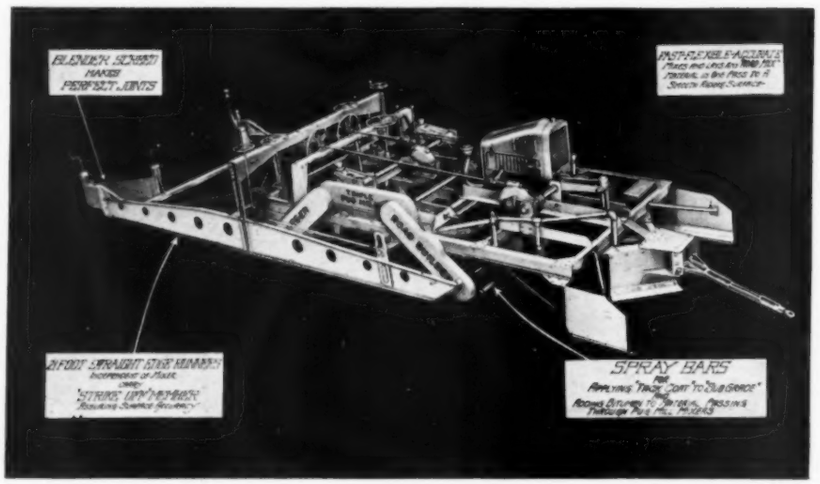
The road builder is used for the mixing and laying of bituminous surfaces up to 2 in. in compressed thickness. It also can be used to mix and lay calcium chloride or sodium chloride stabilized mixtures in one pass up to 3 in. compressed thickness.

The Jaeger bituminous paver also is being featured. This is used for laying all varieties of plant mixed bituminous materials. This machine is adjustable in width to fit various road conditions from 9 to 12

International Model C-CO-T 6-Wheel Chassis



Jaeger Bituminous Paver



Jaeger Road Builder

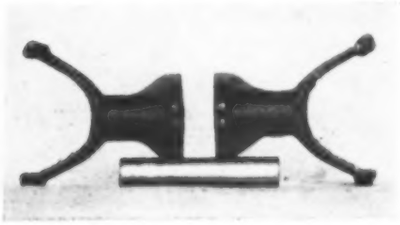
ft. inside of runners and by the use of the blender screeds an additional foot can be laid on each side. The blender screeds also provide instant width adjustment up to a total of 2 ft. by merely operating a handwheel. The machine has ample traction for pushing heavily loaded trucks up steep grades and has working speeds suitable for any bituminous material with a maximum of approximately 30 ft. per minute. For travel speeds or maneuvering on the job it has a very high forward and reverse speed of approximately 150 ft. per minute. On this machine is being featured semi-crawler type wheels which provide a bearing area of 79 sq. in. per wheel. This prevents the wheels from sinking into soft spots and also provides additional traction under adverse conditions. None of the wheels operate on the newly laid material, thus assuring uniform texture. All movements of the machine are mechanically operated and the levers are banked within easy reach of the operator.

The exhibit will be located in Space E-9 and all the company officials will be present at the show, including the departmental and district sales managers.

▼

J. Bar Co. to Feature New Load Transmission Device for Pavement Joints

The J. Bar Co., Chicago, Ill., will feature a new load transmission device for use with all types of expansion and contraction joints, bituminous, rubber, cork and metallic joints.

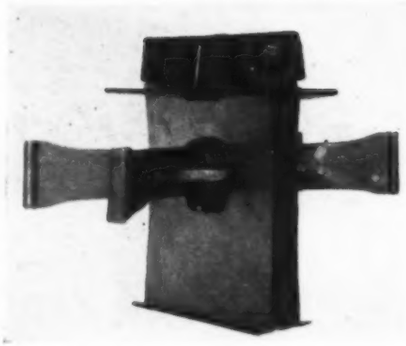


Complete J-Bar Unit

joints. The unit consists primarily of a short dowel bar acting between two anchored and reinforced bearing sleeves. The dowel is made of ¾-in. diameter cold finished bar steel. The two bearing sleeves are made of certified malleable iron. The dowel is 4⅝ in. long and fits snugly in the two bearing sleeves so that a close sliding fit is secured. The sleeve castings are first cored, and afterwards carefully drilled and reamed to a clearance of not more than 0.002 in. The sleeve provides contract for the dowel over a length of 1½ in. and is 3/16 in. thick.

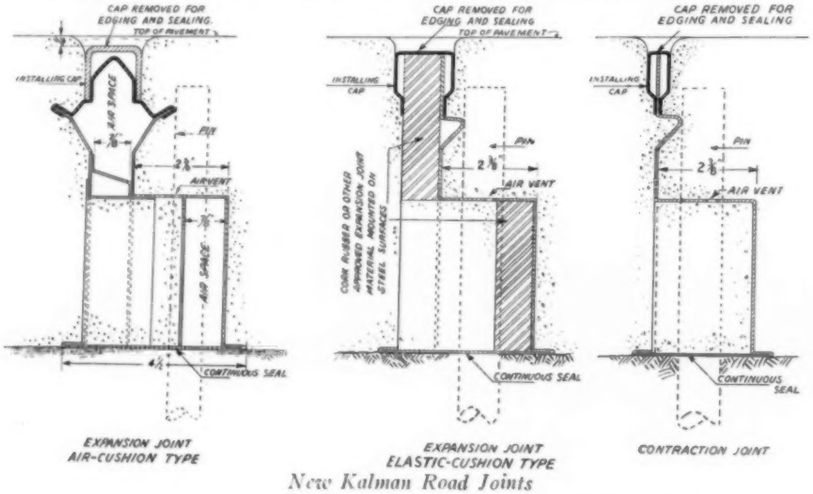
Opposite the expansion space at the closed end of the sleeve the cored hole is slightly larger. The open end of the sleeve casting is strengthened at point of contact with the joint by means of a circular flange ¼ in. in width, ⅜ in. thick, and with its face normal to the axis of the dowel. Two bearing lugs, one on each side of the sleeve casting, lay in a horizontal plane, are ¼ in. thick, extend out at least ¼ in. beyond the flange and back along the body a distance of ½ in., whence they gradually taper back toward the body of the casting for a distance of approximately ½ in.

The end of the casting away from the face is closed, and an expansion chamber provided, allowing for complete closing of



J-Bar Load Transmission Device Inserted in Short Section Ace Copper Sealed Joint

the unit without obstruction. This same end is provided with wing anchors spreading away horizontally from the body of the casting a distance of not less than 1⅞ in. at right angles to the center line or 3¾ in. over all, and extending back from the face of the slab a distance not less than 4 in. These wing anchors taper from a vertical section 1⅛ in. high x 3/16 in. thick, to a section 1½ in. high x ⅛ in. thick where they enlarge into a cylindrical lobe or key ⅜ in. in diameter. For installation purposes only, suitable means are provided to draw the two faces of the sleeves into firm contact with the joint in such a manner that the complete unit cannot rotate and must remain in alignment with the joint. The J-Bar can be used in all types of expansion



New Kalman Road Joints

in. beyond the center of the post. Made of spring steel, the bracket is designed to sustain the rail plate against heavy impact without sacrificing the essential resiliency.

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Kalman to Show New Products

The following products will be displayed by the Kalman Steel Corporation, Bethlehem, Pa.: Kalguard (highway guard); transverse expansion joints—air-cushion and various solid-cushion types; dowel supports and other types of reinforced concrete construction made up of various shop fabricated material; highway sign posts and snow fence posts of steel.

The Kalguard and expansion joint are two new Kalman products which have been introduced on the market within the past year. Kalguard is rolled from high-strength, semi-spring steel to any gauge specified, and to a smooth, even surface. An important feature is the bracket which is composed of a semi-circular shock absorbing element located directly in front of the post and a spring leaf which extends 12

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Klauer to Show New Plow

The Klauer Manufacturing Co., Dubuque, Ia., will have a special exhibit of a new

New Model TU-3 Snogo

model TU-3 Snogo mounted on a 4-wheel drive truck. The unit will be equipped with an electric motor drive so that the working parts in motion can be shown. The exhibit will be located in Booth H-20.

Kinney Mfg. Co. to Show New Distributor

The Kinney Manufacturing Co., Boston, Mass., will exhibit a 1,000 gal. distributor built in long, low model and mounted on one of the new model White trucks, streamlined type, with two rear axles and ten wheels. The tank will be insulated with Alfol. Pump will have a capacity of 405 gpm. at top governed speed with three lower speeds available for operation, with a new type of micrometer control on the pump for close regulation of the pump speeds. The engine driving the pump will be the IXB Hercules 36 h.p. at top governed speed.

Kinney Distributor

The exhibit will be in Booth B-7. Representatives in attendance will be: W. E. Worcester, Vice President in Charge of Sales, Boston office; C. C. Hill, Salesman. Boston office; C. D. Campbell, Jr., Manager, Philadelphia office, 725 Commercial Trust Bldg., Philadelphia; A. J. Munday, Manager, Chicago office, 1202 Buckingham Bldg., Chicago; R. C. Webster, Salesman, New York office, 30 Church St., New York City.

Koehring Co. Exhibit

The Koehring Co., Milwaukee, Wis., will have its exhibit in Booth A-8 where it will show equipment. All officers as well as sales and advertising departments will be represented.

Lauson Co. to Show New ½ H.P. Engine

The Lauson Co., New Holstein, Wis., will display a new ½-h.p. ball bearing, four-cycle, air-cooled engine. This little unit is complete with Eisemann magneto, balanced crankshaft, hardened and ground cams. It will operate at a speed of from 1800 to 3600 r.p.m. developing from ½ to ¾ h.p., depending upon speed. Connecting rod and piston are of aluminum alloy. Intake and exhaust valves are mechanically operated. The engine is of the "L" head design. It is equipped with a flyball governor, maintains a close speed regulation for operating generators and other types of machinery. The total height of the engine is only 11-in. Its neat, compact construction makes it easily portable.

The Lauson Co. will also show other models of Lauson vertical air-cooled engines in the 1, 2 and 3 h.p. sizes; vertical radiator cooled models in the 2, 4 and 5 h.p. sizes, as well as horizontal units.

Le Tourneau to Show New Equipment

R. G. Le Tourneau, Inc., Peoria, Ill., and Stockton, Calif., will show one of their 6-Yard Carryall Scrapers operating with a 15 h.p motor and their new Cradledump wagon in connection with the Hug truck and Caterpillar D-13,000 motor. They will also show the heavy-duty rooter, their Crane, one of their Angledozers on a Caterpillar RD-7, and another one of their new machines, a 24-Yd. Earthmover, in back of a Caterpillar RD-8 tractor. The front of the tractor will be equipped with the new front Power control unit which they have just completed. The Earthmover will be operated by an electrically-driven motor. They will have a display of enlargements showing their equipment in working conditions and giving some information, such as job data and performance. There will undoubtedly be some space devoted to the company's early history, with a few photographs showing the development of the machine from its early stages, also a few of the innovations they pioneered.

Lima to Show 2¼ Yd. Shovel

The Lima Locomotive Works, Inc., (Shovel and Crane Division), Lima, O., will exhibit its 2¼ cu. yd. combination shovel, dragline and crane in Booth A-6. Ths new machine is equipped with all the latest features which insure greater yardage, less up-keep and lower fuel consumption. The rotating frame, upon which the operating machinery and power unit are mounted, is a one-piece steel casting, thoroughly annealed. On this casting are mounted the supports which carry the drum shafts. The drums are extra large in diameter and are wide enough to carry the maximum amount of cable without double wrapping when the machine is operating as a crane or on high lift work. The clutches are the interior expanding type and power set. The brakes are over size with ample cooling surface. Helical cut gears are used throughout. Roller bearings are used at every vital bearing point. All major motions are independent, making it possible to hoist, swing, travel and raise or lower the boom at the same time. Levers are mounted on square shafts for positive and instant response of each function. All shafts, on which are sliding members, are splined. An instrument panel, with starter, is located within easy reach of the operator from his position in the cab. The machine is steered from the operator's position with the cab in any position. The crawler truck is the large open-roller type, chain driven. The crawlers are so designed that they can be extended in length when greater bearing surface is desired. Changing from long crawlers to short crawlers, or conversely, can be made in the field. The boom and dipper handle are of the box type design, electrically welded throughout. The dipper is cast in one piece of manganese steel with detachable lip. The independent crowd is accomplished by a roller chain which follows the center line of the boom. The cab is all steel construction with two-thirds of its area readily opened for ventilation. The Type 901 comes equipped with oil, diesel or electric power.

Le Roi to Show New Power Unit

The Le Roi Co., Milwaukee, Wis., will exhibit air compressors, generator sets and power units. One of these power units will be on exhibition for the first time at this convention. The exhibit will be in Space E-13. Representatives of the company who will be present at this Show are Messrs. C. W. Pendock, W. R. Karll, D. Heffron, and G. D. Moore.

Lima 2¼-yd. Combination Shovel, Dragline and Crane.

Littleford to Show New Distributor and Traffic Line Marker

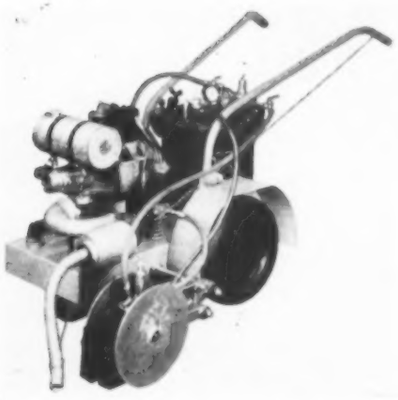
The exhibit of Littleford Bros., Cincinnati, O., will feature a Model "C" pressure distributor. Two brand new articles will also be there—The No. 101 utility spray distributor and a new traffic line marker, the Littleford Traf-O-Spray. In addition to these units will be the asphalt kettle, the No. 84-HD—but it also will be a new and improved No. 84-HD.

The Traf-O-Spray is a small, compact, sturdily built unit, designed to spray painted lines on highways. It has an air-cooled motor-compressor unit, combined with a paint reservoir and gun ingeniously mounted on a handy chassis with pneumatic tires.

The No. 101 sprayer represents what might be considered a junior model of the large Model "C" pressure distributor. It has been designed principally to serve users of oils, cut-backs and emulsions for large skin patching jobs and shoulder redressing work.

The exhibit will be in Booth E-7. Roger Littleford and John S. Littleford, Jr., members of the firm; Larry Glaser, Sales Manager; John Strobel, Asst. Sales Manager; Herbert Haupt, Chief Engineer; M. A. Smith, Advertising Manager, will be in attendance.

Littleford Pressure Distributor.



Traffic Line Marker—"Traf-O-Spray."

Macasphalt Exhibit

The exhibit of the Macasphalt Corporation of America, Flushing, N. Y., will be in Booth F-12. Messrs. O. H. Berger, W. R. Yoakley and A. W. Von Der Linn will be in attendance.

Lufkin to Exhibit Tapes, Rules and Tool

The Lufkin Rule Co., Saginaw, Mich., will show a complete line of measuring tapes, rules and tools such as are commonly used in road building. The exhibit will consist of two 8-ft. plate glass cases showing a representative line of goods such as indicated above. Representatives attending the convention will be R. M. Benjamin and Gordon Carpenter.

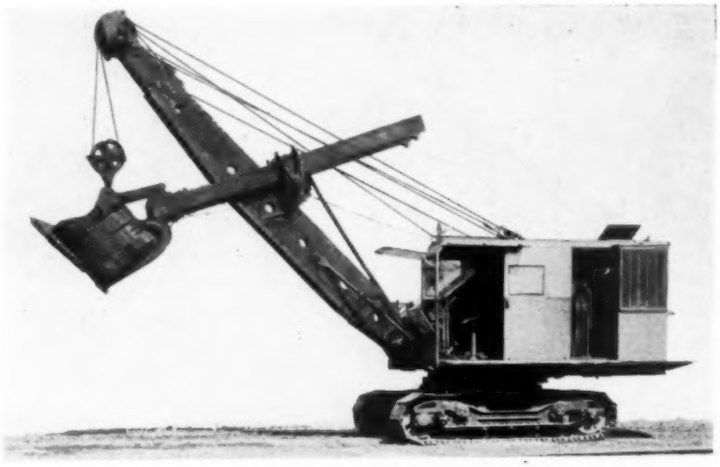
Medusa Products Exhibit

The principal things exhibited by the Medusa Products Co., Cleveland, O., will be Medusa white cement for white markers and curbs, waterproofed gray cement and cement paint. The exhibit will be in Booth H-5 and will be in charge of Philip Mooney and C. E. Wyman.

Marion to Exhibit Two Shovels

The Marion Steam Shovel Co., Marion, O., will exhibit two of its friction type shovels: The Type 331 machine, ¾ cu. yd. capacity, powered by a Buda 4-cylinder gasoline engine, and the Type 361 machine, 1½ cu. yd. capacity, powered by a Caterpillar diesel engine.

The exhibit will be in Section B-26 and will be in charge of P. E. Piersol; other members of the Marion organization also will be in attendance.



Marion Type 361 Shovel.

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Michigan Power Shovel Co. to Show New Model

The Michigan Power Shovel Co., Benton Harbor, Mich., will show an entirely new model of its truck shovel. This shovel, convertible to crane, dragline, clamshell, trenchhoe, backfiller or skimmer, is powered by a Hercules model JXC 6-cylinder, size 3¾x4½, cubic displacement 282; maximum h.p. at 1800 r.p.m. 57. Larger motor may be furnished at slight additional cost for high altitudes. The transmission is heavy duty automotive type, 4 speeds forward and 1 speed reverse. The road speeds at 1800 r.p.m. of motor are: Low gear, 3.42 m.p.h.; second gear, 6.5 m.p.h.; third gear, 12.5 m.p.h.; fourth gear, 21.68 m.p.h.; reverse gear, 2.8 m.p.h. For shovel operation motor is governed at 1350 r.p.m. The weights are: Shovel, 18,000 lb.; crane, 25-

New Michigan Convertible Shovel

ft. boom, 16,900 lb.; crane, 30-ft. boom with additional counterweighting, 18,000 lb.; basic machine, standard counterweights, 15,700 lb. The dipper is ⅜ yd. struck measure, of heavy construction with cast steel back. The exhibit will be in Booth D-4 and the following representatives will be in attendance: D. H. Ross, A. P. Ross, M. S. Ross, Geo. Davis, A. L. Bliven, L. M. Randall, R. E. Zebell, O. B. Law.

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National Colortype to Exhibit Traffic Signs

The National Colortype Co., Bellevue, Ky., will exhibit highway markers and traffic signs, including its U. Standard embossed signs and its Fireball reflector button type signals.

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National Paving Brick Association to Show Miniature De-airing Machine

The National Paving Brick Association, Washington, D. C., will have on display in Booth G-1 samples of the latest type of paving brick including those manufactured by the de-airing process. In addition to this there will be literature for distribution regarding the proper method of using vitrified brick as a paving material including the new specifications for brick pavements recently adopted by the American Society of Municipal Engineers.

It also is expected to have a miniature de-airing machine furnished by one of the brick machinery manufacturing companies which will illustrate the use of the de-airing process in producing a clay column that is denser, tougher and stronger in structure.

A. Campbell, Assistant Chief Engineer, and G. F. Schlesinger, Engineer-Director, will be in attendance.

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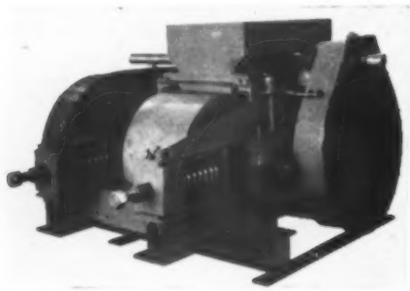
Pioneer to Exhibit Crusher and Screen

The Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn., will have the following equipment on display: Pioneer 30 in. x 18 in. roll crusher, No. 55 counterbalanced horizontal gradation screen, and model jaw crusher. The space number is D-10 and the

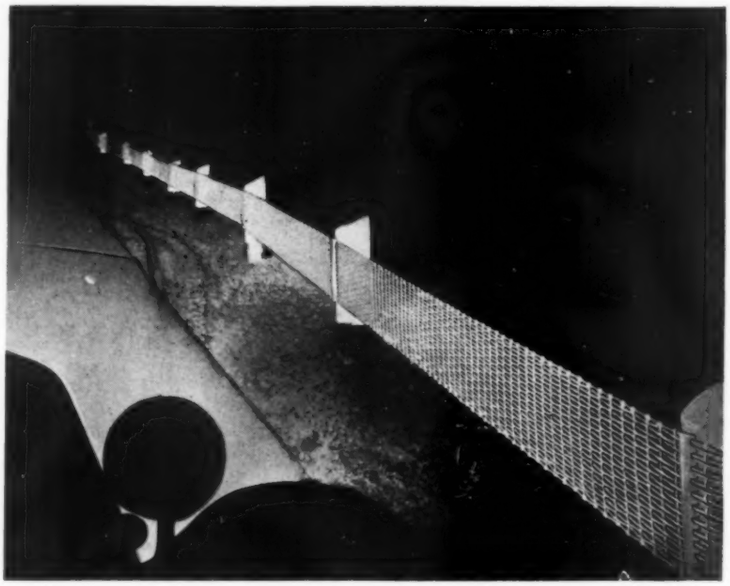


Pioneer 30 in. x 18 in. Roll Crusher

the following representatives will be in attendance: L. W. Yerk, President; K. E. Brunsdale, Secretary-Treasurer; C. K. Ordway, Salesman; M. Ovestrud, Superintendent.

Pittsburgh Steel Company Exhibit

Pittsburgh Steel Co., Pittssburgh, Pa., will exhibit in Space H-22. In addition to its line of Pittsburgh welded wire reinforcing and cleft-joint installation equipment the exhibitor will also show the new Pittsburgh safety highway guard and highway tape, both of which are now offered painted white—in addition to their heavy galvanizing—for extreme visibility and further reduction of accident damage in night driving. Robert L. Glose, manager of welded wire fabric sales; W. S. Edge and O. F. Arthur, from the company's general office at Pittsburgh, will be at the show, together with W. L. Whitman from Philadelphia, R. W. North from Detroit and Geo. N. Malcolm from Cleveland.



Pittsburgh Safety Highway Guard

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Portland Cement Association to Have Animated Exhibit

The display of the Portland Cement Association, Chicago, will consist of an animated exhibit picturing the economies of driving over high type pavement. The same exhibit carries a message showing the necessity for using road funds for road purposes. There also will be on display a revolving cabinet of colored transparencies illustrating concrete roads in various sections of the country. With the addition of other enlarged photographs to augment this display, the association will have copies of its informative publications on road and street design and construction.

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Ransome Exhibit

The Ransome Concrete Machinery Co., Dunellen, N. J., will confine its exhibit to display of literature and photographs and a moving picture reel. Literature will be available on the Ransome dual drum paver and the 7S and 10S end discharge mixers, recently brought out by the company. The exhibit will be in Booth E-5 and the following will be in attendance: W. Muller, J. P. Faber, J. C. Lukas, L. R. Wilson.

W. A. Riddell Co. to Show New Item

W. A. Riddell Co., Bucyrus, O., will have on exhibition a Model 35 Grader, mounted on an Octopus, also J & S Traction Threads for both single and dual pneumatic tires. One item on display is being shown for the first time. This is a new addition to the line of traction tread equipment, known as J & S Traction treads for single pneumatic tires. These treads, for giving added traction in mud, sand, snow and ice, are very similar in construction to the J & S Traction treads for dual pneumatic tires which have been manufactured for quite some time. They are so designed as to give maximum flexibility, are simple in construction and very easily mounted. The material used in the construction of these treads is of the best obtainable. Wearing shoes are of special alloy steel castings; links and pins are made of high carbon heat treated steel; pins are large and easily removed by the simple method of removing but one keeper lock ring. The treads are also very quickly and easily

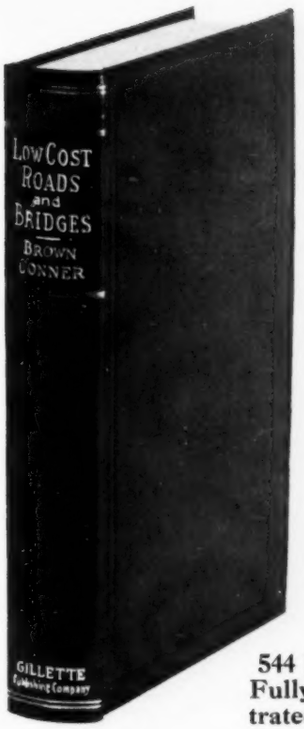
J & S Traction Treads

LOW COST ROADS and BRIDGES

by

V. J. Brown, C. E.
Assoc. Mem. Am. Soc. C. E., Mem. Western Soc. Engr., Mem. Am. Road Bldrs. Assn.

C. N. Conner, B. S. in C. E.,
Engr. Exec., Am. Road Bldrs. Assn., Mem. Am. Soc. C. E., Mem. Am. Soc. Testing Mtls., Com. Chmn. on Low-Cost Roads of Highway Research Board.



544 Pages Fully Illustrated, $6.00

Any new technical book is, in the nature of things, bound to be, in the main, a compilation of what has already appeared in print. Few authors, however, admit it so frankly as do Messrs. Brown and Conner —"The authors' problem was one of selection, correlation and synthesis, rather than research, experiment and analysis." Such frankness predisposes the reader favorably to their book, but this should be well received for its own sake.

In ten well-arranged chapters the authors have covered the fundamentals of highway design, economics and planning, grading, surface treatment, low-cost paving materials and their testing, inspection and maintenance. An additional chapter discusses highway bridges. Although the book is not overloaded with illustrations, there are enough to make clear the text.

Heavy-traffic arteries warrant enough expenditure so that it is relatively easy to decide upon the treatment they shall receive, but what to do with the many times greater mileage of roads on which traffic is often so light as to be almost non-existent, is not so easy to decide. It is with this type of highway that the book is concerned, written for the county engineer and others like him, whose most difficult problems are those just mentioned.

In a work of this kind, one would not expect to find any discussion of the more expensive types of surfacing—sheet asphalt, brick, stone block, etc.—nor does it appear. The treatment of the lower types, however, is entirely adequate. The authors have not hesitated to enlist the co-operation of a number of specialists, which, if detracting somewhat from their own glory, adds much to the value of their book.

A thorough-going discussion of low-cost highways has long been needed; the authors are to be congratulated upon their work, which will surely find a ready sale to those who have to do with highway affairs.

adjusted. An adjustable master link compensates for tire wear.

The inside of the tread plate is a smooth surface curved to fit the contour of the tire. They do not mar or injure the tire in any way; in fact, by actual test on machines doing heavy construction work, they have been found to preserve the life of the tire. These treads are held against the tire with sufficient tension to prevent their chafing or slipping.

The exhibit will be in Booth D-17 and those in attendance will be N. E. Jersey, Sales Manager, R. S. Spencer and D. F. Baumgartner.

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R. B. Equipment Co. to Show Fine Grader

The exhibit of the R. B. Equipment Co., Royal Oak, Mich., will be in Booth D-5. Among the other equipment shown will be one of the R-B power finegraders. The following will be in attendance: R. D. Baker, Paul B. Cochran, M. F. Bornor, John Gronlund, A. M. Guthrie.

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Roads and Streets

ROADS AND STREETS, Chicago, will occupy Booth G-8. Those in attendance will be Charles T. Murray, J. C. Black, J. M. Angell, C. A. Blauvelt, B. C. Brumm and E. C. Kelly, all with headquarters at Hotel Statler. Mrs. E. L. Powers of Powers Road and Street Catolog also will be at the show.

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Rome to Show Late Model Graders

The Rome Grader & Machinery Corporation, Rome, N. Y., will exhibit a late model Rome "high lift" drawn grader and a Rome power controlled motor grader. The exhibit will be in Space C-26 and J. M. Patterson and Geo. D. Finney will be in attendance. Their headquarters will be at the Hotel Statler.

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Sauerman Bros. Exhibit

The exhibit of Sauerman Bros., Chicago, Ill., will consist of a photographic display of its machinery and its application in work of interest to road contractors, general contractors, and highway officials. Also there will be on exhibit small models (not working) of the various types of excavating buckets that it manufactures. The exhibit will be in Booth H-42. G. H. Tompkins and D. D. Guilfoil will be at Cleveland during the entire period of the show. Other members of the organization will be there for some period of the time.

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Sinclair to Distribute Literature

The Sinclair Refining Co. (Headley Asphalt Division), New York, will occupy Booth F-6, which it will use as its headquarters and where it expects to disburse some literature.

It also is expected to have headquarters at the Hotel Hollenden. The following representatives will be in attendance: J. G. Campazzie, H. W. Weeks, F. X. Kern, W. T. Gilbert, M. W. Lefever, J. D. George.

Schramm, Inc., to Show New Outfit

The display of Schramm, Inc., West Chester, Pa., will consist mainly of single and two-stage gasoline engine and diesel engine driven units representing the most important numbers in the Schramm line, as well as designs that will reflect the progress that has been made within the past two years. It also is expected to show a new "Utility" outfit.

The exhibit will be in charge of A. O. Witt, Manager Sales Promotion. Henry N. Schramm, President, will be in attendance and the Chicago manager, G. S. Boers and several others of the sales force.

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Scintilla Exhibit

The exhibit of the Scintilla Magneto Co., Inc., Sidney, N. Y., will be located in Booth H-4. The exhibit will consist of Bendix magnetos and Scintilla magnetos for tractors and other road equipment. Numerous minor improvements have been incorporated but in general the line is unchanged.

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T. L. Smith Co.

T. L. Smith Co., Milwaukee, Wis., in common with the other mixer manufacturers, will have no physical exhibits. However, the company will occupy Booth E-3 where its distributors and friends can gather. H. C. Peters, Fred Bager and Mr. Smith will be in attendance.

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Speeder to Exhibit Diesel Tractor Shovel

The Speeder Machinery Co., Cedar Rapids, Ia., will exhibit a model TS-40 Diesel tractor shovel in Space B-14. This is the first time that this particular machine has been exhibited at a national road show. Those in attendance will be T. M. Deal, president; Edgar McNall, advertising manager; B. O. Eighmy, sales engineer, and D. W. Lehti, chief engineer. The mounting for this shovel is Caterpillar wide gage Diesel or gasoline 40 tractor. The power for traveling and operating is furnished by the tractor motor through a simple Speeder patented transmission. The tractor remains intact. The Speeder tractor shovel can be converted to tractor for regular tractor work within a few hours. The construction is extra heavy in every detail, and it is stated that the crane (with "40" tractor) will lift nearly 3 tons at 10 ft. radius with a 22-ft. boom. The shovel boom is 14 ft. in length; all buckets for the "40" tractor are ⅜ yd. capacity.

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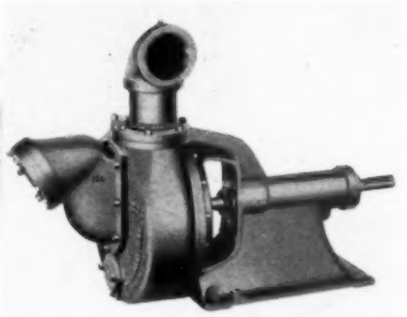
Sterling to Show Belt-Driven, Self-Priming Centrifugal Pump

The Sterling Machinery Corporation, Kansas City, Mo., will exhibit double ball bearing belt drive centrifugal pumps. The bearing stand of these pumps is equipped with two dust-proof ball bearings of high grade manufacture and the shaft is of stainless steel. The pumps are constructed in the same manner as are the Sterling Quality gasoline engine or electric motor driven direct connected selfpriming centrifugal pumps.

Sterling also contemplates showing an 8-in. selfpriming centrifugal pump mounted on a Waukesha Hesselman oil engine. This will be a second piece of equipment that will be shown for the first time by Sterling Machinery Corporation. It also is expected to exhibit two 2-in. engine driven, selfpriming centrifugal pumping units, one 3-in. and one 4-in. engine driven selfpriming centrifugal pumping units. An engine driven electric generating plant will be shown and there also will be on display a 2-in. selfpriming centrifugal pump equipped with an electric motor which will be in operation during the show.



Sterling Double-Ball Bearing Belt Drive Selfpriming Centrifugal Pump.

The exhibit will be in Booth C-20 and the company will be represented at the road show by Messrs. Barzen, Ohler and Cameron.

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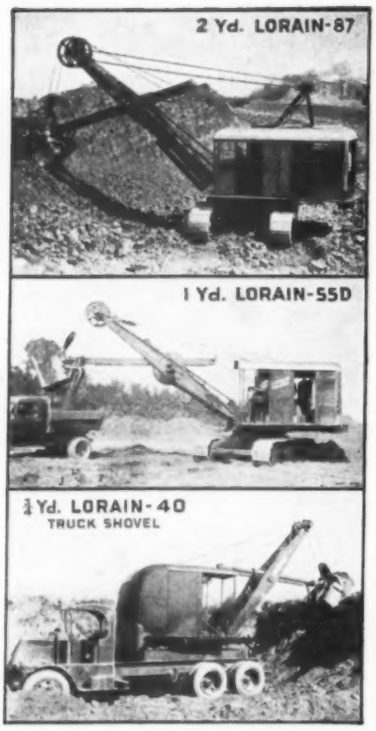
Thew to Announce 3 New Machines

The 1936 Cleveland Road Show will signal the formal announcement by the Thew Shovel Co., Lorain, O., of 3 new Lorain models. These are: 2 yd. Lorain-87; 1 yd. Lorain-55D; ¾ yd. Lorain-40 truck shovel. Of these the 2 yd. Lorain-87 and ¾ yd. Lorain-40 truck shovel will be on exhibit at the space of the Thew Shovel and Universal Crane Co. In addition to these, there will be exhibited a 1½ yd. Diesel Lorain-77 and a ¾ yd. Lorain-40 crawler dragline.

The 2 yd. Lorain-87, built throughout to Thew center drive design, is equipped with a 24-ft. shovel boom. It is virtually 2 booms in one—one, a structural member which absorbs all bending and compression forces—the other, a tubular, torsional member that absorbs and resists all boom twisting and torsional stresses. Each is independently connected to shipper shaft and to boom hinges so that each is called upon to absorb only those stresses for which it is designed.

The 18 ft. dipper stick on the L-87 is made of seamless tubing. It has an alloy steel crowding rack electric welded its full length, which acts as a huge key to keep the stick from twisting.

The hoist, swing and crowd or travel shafts of the L-87 are mounted on Timken roller bearings, as are the swing drums. Internal expanding clutches, controlling these power applications, are of the reversible type, permitting the clutch band and



The Three New Thew Machines

lining to be reversed after initial wear, end for end.

The swing drums are mounted on Timken roller bearings and consist of 2 piece drums—separate pinions and clutch friction rings. The latter are split for easy removal and replacement without requiring dismantling of swing shaft.

Crawler steering, on the L-87, is effected by a hand lever at operator's position and can be carried on regardless of turntable swing position.

The L-77 model will be powered by a 6 cylinder diesel and will show the latest improvements made on this popular 1½ yd. machine. A new swing shaft, with drums mounted on Timken Roller Bearings is now standard equipment.

The ¾ yd. L-40 truck shovel unit will be mounted on an Indiana truck, three axle type, with 10 pneumatic tires.

The L-40 dragline to be exhibited will be a crawler unit, with 30 in. wide treads as used for extremely low ground pressures, equipped with a 35 ft. boom and ¾ yd. dragline bucket. This unit is built to a new design principle which gives strength, stability and capacity without excess weight; as a consequence it weighs only 29,000 lb. It will be shown mounted on a L-40 single purpose 6 wheel, 12 tire, trailor specially designed for the transportation of this unit.

The new 1 yd. Diesel L-55D unit will be demonstrated at the Lorain factory, 25 miles west of Cleveland. Special bus service, on regular schedule, will be maintained between Lorain and Cleveland for the transportation of those who wish to see the various Lorain units in actual performance at the Thew proving grounds. A trip through the factory, showing how the various units are built, is a part of this trip.

The new L-55D is now built with a longer turntable, with a 19-ft. shovel boom, and is mounted on a heavier crawler, 12 ft. 3 in. long. It is powered by a 4 cylinder Diesel engine. Its crane capacity is 15 tons at 12 ft. radius.

In addition to the L-55D, the following units will also be shown at the Lorain factory.

1. Lorain-95, long range, big capacity dragline; 65 ft. boom, 2 yd. bucket; 2. ¾ yd. Lorain-40 shovel (weight 33,000 lbs.); 3. ½ yd. Lorain-30 dragline.

Toncan Culvert Manufacturers' Association Exhibit

The Toncan Culvert Manufacturers' Association, Youngstown, O., plans to exhibit Toncan Iron corrugated pipe and Toncan sectional plate. The association will have Booth G-15 and Messrs. A. J. Roof and R. C. Beggs will be in attendance.

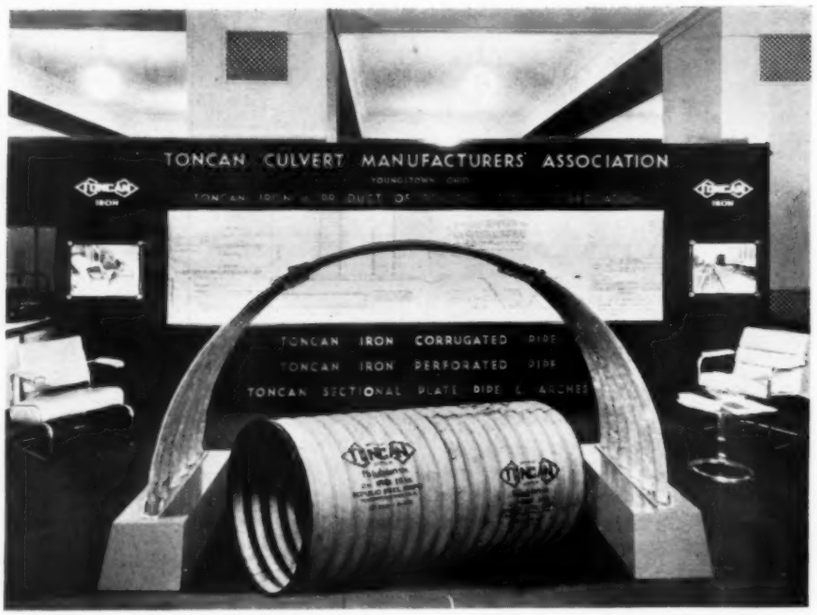


Exhibit and Products That Will Be on Display

Trackson to Feature Shovel

The Trackson Co., Milwaukee, Wis., will display its tractor equipment in Booth E-12. The all-purpose tractor shovel and latest type pneumatic tire dump wagons will be featured. The Trackson high-shovel is supplied on heavy industrial Model G Trackson tracks or wheel tractors. This unit has been improved and will be displayed on the new Trackson McCormick-Deering Model GI-30 Crawler-Tractor.

Trackson Tractor Shovel.

The exhibit will be in charge of L. E. Dauer, Sales Manager. Company officials and sales representatives will also be in attendance, and the hotel headquarters will be at the Hollenden.

Truscon to Display Its Highway Products

The Truscon Steel Co., Youngstown, O., will have a display of its products used in the highway field. The exhibit will be in Booth G-14 and the following representatives will be present: B. C. Briody, vice-president; A. C. Marvin, A. C. Schreiber, R. E. Whieldon and W. N. Conger, representatives of the highway sales department; R. P. Dodds, manager advertising and publicity.

Tuthill to Show Sections of Guard Rail

The Tuthill Spring Co., Chicago, Ill., will display a sample section of Tuthill highway guard rail and will also have motion pictures showing actual tests of the guard rail in service.

An Installation of Tuthill Guard Rail.

U. S. Steel Subsidiaries Combine Products in One Exhibit

A clover leaf intersection, modeled in actual materials at a scale of one inch to the foot, will form the main feature of the exhibit of the United States Steel's twelve subsidiary manufacturers of highway products. On the wall back of the model will be a diagram clearly indicating the manner in which traffic operates over the crossing and connections.

Many of the products will also be shown in full size samples, and there will be continuous motion pictures illustrating the high points and most interesting features of each. The system of highway lighting displayed in the model is of a new type, and will be in operation. The overpass is of the beam-arch type.

The companies represented, and the products they are showing under the motto, "Solving a Safety Problem Safely with U. S. Steel," are as follows:

American Bridge Company
- Beam-Arch Bridge Construction

American Sheet & Tin Plate Company
- Steel Sheets for Culverts
- Highway Signs

American Steel & Wire Company
- Welded and Woven Fabric for Highway Reinforcement
- Highway Guard Cable
- Multisafty Highway Guard Cable
- Amergard Steel Plate Highway Guard Rails
- "Giderite" Highway Signs Posts
- Highway Fence Posts
- "Sno-gard" Snow Fence Posts
- American Tiger Brand Wire Rope
- Bar Mat Highway Reinforcing

Carnegie-Illinois Steel Corporation
- I-Beam Lok Bridge Flooring
- Steel Bearing Piles
- Steel Sheet Piling
- Multigrip Steel Floor Plate
- Concrete Reinforcing Bars
- Standard and Wide Flange Structural Sections

Columbia Steel Company
- Sheet Steel for Culverts
- Tiger Brand Wire Rope
- Concrete Reinforcing Bars

Cyclone Fence Company
- Cyclone Chain Link Road Guard
- Cyclone Chain Link Property Protection Fence

National Tube Company
- Seamless and Welded Wrought Tubular Products
- Tubular Steel Highway Poles and Sign Posts
- Copper-Steel Pipe for Bridge Railings

Tennessee Coal Iron & Railroad Company
- Bars and small shapes
- Plates
- Structural shapes
- Strip
- Concrete Reinforcing Bars, both New Billet and Rail Steel
- Sheets for Road Signs, Culverts, Road Guards, Road Strip, License Tags and all other uses
- Sign Posts
- Special Sign Sections for Sign Manufacture
- Woven Wire Fence
- Strand
- Nails

Universal Atlas Cement Company
- Universal Portland Cement
- Atlas Portland Cement
- Atlas White Portland Cement—Plain and Waterproofed

Scully Steel Products Company
- Warehouse Distributors of all Steel Products required in the Road Building and Allied Industries

Michigan Limestone & Chemical Company
- Coarse and Fine Aggregate for Concrete Roads

Pittsburgh Limestone Corporation
- All sizes High Quality, Washed, Crushed Limestone for use as Concrete Aggregate and in Construction of all Types of Macadam Highways

The space occupied will be H-15 in the North Exhibit Hall.

Among those in attendance through all or part of the show will be C. R. Moffatt, director of Exhibits, U. S. Steel Corp.; Howard G. Marsh, Carnegie-Illinois Steel Corp.; F. D. Rideout, American Bridge Co.; K. R. Nelson, American Sheet and Tin Plate Co.; B. S. Pease and P. T. Coons, American Steel & Wire Co.; O. W. Irwin, Concrete Bar Division, and E. L. Flad, Slag Dept., Carnegie-Illinois Steel Corp.; Robert Denby, Cyclone Fence Co.; H. L. Green, Scully Steel Products Co.; P. F. Keatinge, Atlas White Bureau, Universal Atlas Cement Co., and Reese Price.

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Walter Motor Truck to Show Snow Fighter

The exhibit of the Walter Motor Truck Co., Long Island City, N. Y., will consist of Model FBS, 150 h.p., 5-8 ton, Walter Snow Fighter, equipped with an offset V-plow; right leveling wing, full power hydraulic control; and dump body. The Walter Snow Fighter is a powerful motor truck of special design and construction, developing super traction, due to a unique four point positive drive system, obtained through the use of patented automatic lock or torque proportioning differentials, acting between all four wheels. The exhibit also will include Model FMD, 110 h.p., 4-5 ton truck with dump body. This model embodies all the tried and proven features of Walter construction, and provides a chassis of unusual power but with moderate weight.

The Walter Snow Fighter.

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Wej-Lock Co. to Show Guard Fence

The Wej-Lock Co., Centralia, Mo., will have an exhibit showing Wej-Lock super guard fence. The strand is 1x19 in. wire strand, coated by the Bethanized method, carrying 1.6 ounce of pure zinc per square foot of surface. It is stated the strand will develop a minimum of 104,000 lb. tensile strength and will be preserved more than twice as long as though coated by the hot-dip method.

Installation Wej-Lock Guard Fence

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White Motor to Display New Trucks

The latest models of White and Indiana trucks, specially designed for road building and general construction projects in 1936, will be displayed for the first time by the White Motor Co., Cleveland, O.

As a special feature of the convention program this year the delegates will be invited to visit the famous White factory where they will be shown all the newest machinery for building modern trucks.

One of White's Latest Road Building Trucks

The delegates who visit the White plant also will have a chance to see first-hand the manufacture from the ground up of the new series of completely streamlined trucks styled exclusively for the White Motor Company by the Count Alexis de Sakhnoffsky. White busses will make regular trips from the Auditorium to the White factory for the convenience of the delegates.

Besides having its own booth at the show, White will have models in other booths to be displayed with other manufacturers' equipment. H. P. Starbird, Transportation Engineer, will be in charge of White's display at the Road Show.

Wellman Engineering to Show Buckets

The Wellman Engineering Co., Cleveland, O., will exhibit a Williams dragline bucket and two Williams clamshell buckets. The exhibit will be in Booth H-39 and Messrs. Swalley, Robin and Lichtinger will be in attendance.

Williams Clamshell Bucket

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Wico to Show New Magnetos

Two new magnetos, shown for the first time at any show or convention, will form part of the exhibit of the Wico Electric Co., Springfield, Mass. The exhibit will be in Booth C-8. Those in attendance will be: E. L. Stoughton, President; J. E. Redman, General Sales Manager; H. L. Hart, Mid-West District Manager; C. L. Allen, Factory Representative; V. K. Hunt, Assistant Sales Manager.

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Wheeling to Show New Dowel and Joint Support

The Wheeling Corrugating Co., Wheeling, W. Va., will exhibit the following of its products: Welded wire fabric reinforcing; corrugated metal culvert pipe; tubular bridge railing; Wheeling dowel and joint support. At the booth there will be an operation of a continuous moving picture showing the various steps in the production of the products from the iron ore to the finished product. The only new product that will be exhibited is the Wheeling dowel and joint support. This is a sheet metal device that automatically places the dowel bars and joint material and maintains them in the correct position. Nothing is removed from the concrete after it is once poured, so that there is no question of the dowel and joint material being disturbed. One man can assemble and install all the units of the joint. This assembly can be done either on the sub-grade or alongside the job, so that there is no delay in the operations incidental to the installation of the transverse joint. Several representatives of the company will be at the booth, including T. P. Parks, manager of sales, building materials department, and W. H. Kelley.